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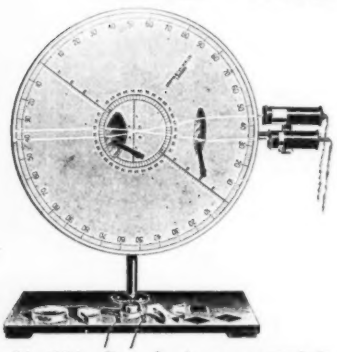

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Current Science

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The Zoological Survey of India.

WE have read the triennial report of the Zoological Survey of India for the years 1932–35 with considerable interest. This document recently issued by the Director presents in a concise and readable form the principal activities in which the departmental officers were engaged during the period covered by the report, and also indicates how the curtailment of grants has affected the progress of investigations. The work of the Scientific Surveys and the knowledge which they advance deserve the attention of governments and also of the public in greater measure than is generally accorded to them. The researches which they undertake are always of great intrinsic importance and frequently of real practical interest, but almost invariably, the value of scientific investigations is neither understood nor appreciated Scientific work in India suffers from lack of proper exponents who can interpret its significance and its bearing on the practical problems of life in the language of the people. Many of the discussions initiated in the Indian Legislative Chambers on important public affairs have a scientific background, and decisions reached have frequently no relation to the proper appreciation of the development and the progress of science in its application to practical ends. It is needless to observe that the intelligent understanding and discussion of many administrative problems necessitates a fairly comprehensive knowledge of the scientific principles involved in their theoretical and practical aspects, and in their bearing on economics and politics as well as on social and legislative measures.

One of the ways, in which the work of the Surveys can be brought prominently before the public, is to extend and co-ordinate the existing Scientific Surveys where such co-ordination is desirable, and to establish a Committee of Scientific Advice. If such a Committee is formed on a representative basis, it should accept the responsibility of promoting discussion in the Council Chambers of Federal India on scientific subjects in their application to economic policy and national well-being. It may be necessary to organise periodical addresses by scientific authorities to the principal political parties, and to assist government in all administrative measures and acts involving the application of modern scientific knowledge. An organisation occupying the

status and fulfilling the duties of the Parliamentary Science Committee in Great Britain is already overdue in India, and the sooner we establish a definite link between Science and Government on the one hand, and Science and Society on the other, the sooner shall we secure the orderly progress of knowledge and the continuous improvement of the economic and social condition of the country. One of the most important truths which the Committee will have to impress on the public and government will be that scientific departments differ in their spirit and character from the administrative branches, and that investigations in the former should proceed uninterrupted by the fluctuations of financial assistance. Our civilisation has progressed by the increasing exploitation of the resources of animate and inanimate nature, and the wealth of the world increases in proportion to such exploitation. The reason why the industrialists invest more money in scientific research when their income falls, is that they live in a competitive world. Starving the scientific departments virtually implies extinction of the industry concerned. But governments as producers of wealth have no competitors, and their attitude towards scientific research correspondingly differs. Like all industrial organisations, government ought to find it more profitable to stimulate the means of earning increased revenue through scientific research, than to resort to the hackneyed policy of enhancing taxes during the recurring periods of financial depression. It is this aspect of administrative policy that the Committee of Scientific Advice that we have proposed should inculcate in the mind of government and the public. Until the political parties realise the imperative necessity of the substitution of such a financial doctrine in the place of the one now pursued, Scientific Surveys are liable to inhibitions of grants.

In the opening paragraph of the report the Director of the Zoological Survey observes that, as a consequence of the scheme of retrenchment applied to his department, the field investigations by the officers were greatly restricted, important research activities curtailed and the staff reduced to a maintenance basis. However the achievements of the Survey during the period reported, form an impressive record comparable with any previous term not affected by financial stringency. This was rendered possible by the unstinted devotion to work already in progress, but there must, however, be a limit to the exertion of unrelieved energy and enthusiasm. The improvement in the financial position of the Government of India offers hope that the grants to the Zoological Survey will speedily be restored to the original scale, without which the arrears of work must continue to exist, and fresh investigations cannot be undertaken. That the work carried on in the Zoological Survey is of such importance as to be recognised abroad is evident from the fact that two of its officers, Dr. S. W. Kemp and Lt.-Col. R. B. Seymour Sewell, were selected to lead oceanographical expeditions sent out by Great Britain within the last ten years. The wealth of research material and the facilities for investigation of practically every species of problem available in the Survey attract Zoologists from foreign countries, besides large numbers of research workers from the Indian Universities and other scientific institutions.

The main feature of scientific progress is the close and steady co-operation between different groups of investigators, since the discoveries in any branch of science find ready application in apparently unrelated departments of knowledge. We have several research institutions in India equipped and maintained by government subsidies, and prevention of overlapping of effort and of duplication of expenditure is a problem worth consideration. In what directions and to what extent intimate co-operation can be secured so as to save expenditure, and to secure at the same time concentrated action, must be one of the duties of the Committee of Scientific Advice already suggested. There are several directions in which the economy of Government grant and of the effort of investigators could be effected. For instance quite a considerable volume of taxonomic work in entomology is done at the different agricultural and forest research institutions in India, and also under the auspices of the Medical Research Fund Association. It would be advantageous, and in certain respects even necessary, to centralise this department of enquiry, as far as possible, at a single institution possessing the requisite laboratory and library facilities, and adequate reserve collections for comparative study. The experience and knowledge of the officers of the Survey and of the members of the subordinate staff when co-ordinated with those working in other research institutes should prove an invaluable implement for the elucidation of problems in which field

work forms the basis of all entomological investigations. Extension of the Entomological Section of the Zoological Survey of India would appear to meet all the demands, provided it gains affiliation and co-ordination of the work carried on in the different centres in such fields of investigation as co-operation would advance. Similarly for the more intense ichthyological research in India, the Fish Section of the Zoological Survey of India could be strengthened to considerable advantage, to which the fisheries departments in the provinces might contribute their experience and knowledge. We are not thinking of the centralisation of research, but only examining the possible advantages of creating a central body where problems in economic zoology could be investigated from a broader and comparative standpoint, and in the elucidation of which the provincial research institutes could honourably co-operate. What we want is research *rapprochement*. This is gradually being established by the Zoological Survey in undertaking detailed investigation in connection with the shell fisheries in the Andamans and their economic exploitation ; the identification of the animals of economic importance from the medical or sanitary point of view for the Calcutta School of Tropical Medicine, the Forest Research Institute, Dehra Dun, the Imperial Institute of Veterinary Research, Muktesar ; the identification of the human and animal remains excavated at Harappa, Mohenjo-daro and other chalcolithic sites in Sind, and the anthropological work connected with the last Census operations. On account of retrenchment, the survey officers have been assigned work which ought to be properly entrusted to the members of subordinate staff, and if they are released from the routine business, they ought to be able to undertake considerably more useful investigations in addition to the legitimate duties connected with their respective office.

The Zoological Survey of India is entrusted with the care and maintenance of the zoological and ethnological galleries of the Museum which in their richness and variety have few parallels in the East. Lack of funds has affected this department quite as seriously as the other sections of the Survey. The official view of the Museum is that it is generally a place for the gratification of the eye, and the message of the exhibits is therefore permitted to remain sub-conscious. It is essentially an educational institution carefully devised for popular enlightenment. It is also a place of reference. Want of proper care and attention due to attenuated staff, and of periodical additions in a bright and attractive form which naturally implies expenditure of money, must rob this section of the Zoological Survey of its power to instruct the visitors and of its usefulness to research students. In 1933, the Director of Zoological Survey was able through the munificence of Dr. S. C. Law to organise an exhibit of storks in a replica of their natural surroundings, and other groups of animals can be exhibited similarly, provided sufficient funds are placed at the disposal of the authorities. In addition to increased grants from governments, the Museum of the Survey should have a large endowment without which further improvements become difficult. The Museum is a great national institution, the usefulness of which is capable of being extended by organising a series of popular lectures on scientific subjects. The presence of foreign scientists who visit the Zoological Survey may be utilised for supplementing the excellent resources which the institution already possesses for inaugurating the scheme of popular addresses in a manner similar to those organised by the Royal Institution of Science and Technology in South Kensington.

The Zoological Survey is now under the direction of Indian scientists and in spite of the limitations imposed by retrenchment, they completed several important pieces of research, and started a large number of interesting investigations during the period under review. It seems to us that in addition to laboratory and field investigations, special branches of research in experimental and economic zoology should be organised when funds become available. No institution in India has such material resources and wealth of experience and knowledge for organising these new departments, as are possessed by the officers of the Survey, and the value of the results of such enquiries for promoting the material prosperity of the country must manifestly be multitudinous. It is true that the work of the Survey is increasing far too rapidly to be handled by the existing staff, and we should be reluctant to make proposals likely to add to their burden. The Zoological Survey is already engaged in important economic problems, but nevertheless the field of investigation is capable of enlargement. Our knowledge of economic ornithology and mammalogy of India is imperfect, and there are gaps in our

information regarding economic pisciculture and entomology. From the triennial report of the Director, we understand that he has submitted to the Government of India proposals for the extension of the department and increase of grants, and, in considering these proposals, we have no doubt that the authorities, while Indianising the services, will also provide them with the necessary means of maintaining their high standard of efficiency and traditional reputation.

Control of Drugs in India.

THE menace of drug adulteration and of traffic in spurious drugs prevalent in India at the present time was the subject of an address by Lieut.-Col. R. N. Chopra, before the Calcutta Rotary Club last month. The speaker showed that the market in India was being flooded by unscrupulous traders with drugs and chemicals of defective strength and impure quality and that potent remedies such as sera, vaccines, gland products and compounds of arsenic and antimony were being freely sold to the public without their quality being tested. The practice was a great menace to the public health and called for prompt institution of efficient safeguards to ensure the quality and authenticity of medicinal preparations offered for sale to the public. There is no doubt that India is *par excellence* the dumping ground for every variety of quack medicines and adulterated drugs manufactured in all parts of the world and that her markets are glutted with useless and deleterious drugs sold by unqualified chemists who are themselves a public danger. That this state of affairs has been going on for some years is shown by the fact that in 1930 the Government of India appointed a small *ad hoc* committee under the chairmanship of Lieut.-Col. Chopra to explore and define the scope of the problem and to make recommendations. The committee started work in October 1930, toured all over India and received a large mass of varied and voluminous evidence both written and oral. It considered carefully and systematically all aspects of the question and in April 1931, made comprehensive and far-reaching recommendations. It is nearly five years since the committee completed its labours and made its report but no action has been taken by the Government and the speaker showed that the position has gone from bad to worse. There is no doubt that all classes of drugs, those belonging to the British Pharmacopœia, those not officially recognised by the pharmacopœia but known and approved medicines including the group of biological products such as sera, vaccines, preparations of animal glands, organometallic compounds, and lastly the group of patent, proprietary and secret remedies are all equally affected. Col. Chopra went into detail of how these different groups were affected and described what was the effect of the substitution of genuine medicinal products by rubbish, which, according to him, has now reached a very serious stage. In diseases such as pneumonia, diphtheria, etc., it may make all the difference to the life of the patient whether he is getting a drug of proper strength or an adulterated or useless preparation. In the case of the complicated organometallic compounds, if they are not properly prepared and tested and in a state of absolute purity, their use will be positively dangerous and fatalities may occur. In the case of biological products incalculable harm may follow the use of products which are improperly prepared or stored. The injection of faked insulin in cases of diabetic coma may lead to the death of the patient. Much harm may result from the use of patent and proprietary and secret medicines in negative as well as positive ways. A patent medicine might be injurious and cause direct harm as in the absence of control some of the constituents may be positively dangerous. Some medicines might have the effect of masking early symptoms of serious and grave diseases and, assuaging them for a short period result in delay of scientific diagnosis and treatment. Col. Chopra performed a public duty of prime importance in bringing to their notice the grave danger the people are running in the absence of control over medicinal preparations. He emphatically pointed out that the Government is morally bound to take steps to rectify the present state of affairs.

The remedy has been suggested by the Drugs Enquiry Committee. The scheme put up by that Commitee, which has been generally accepted as being sound and effective, consists of two parts, namely legislation and the machinery to collect and test drugs. As regards the first part, it is a matter of common knowledge that there is no enactment in the Indian legislature at the present time which aims directly at the

prevention of adulteration or which ensures conformity to proper standards of purity and strength. Although most of the provinces have some sort of legislation, this is generally ineffective; moreover to bring about effectiveness and uniformity of control the legislation should be central and for the country as a whole. This part of the scheme would not entail any monetary expenditure and there is no reason why it should not be proceeded with immediately. Even if mere enactment of legislation by itself is not effective, it will produce a considerable moral effect and in that way will serve as a deterrant. Besides, if this is done time will be saved in future when funds do become available as along with legislation for the control of drugs, legislation, for control of the profession of pharmacy, which in India is still unorganised, will have to be enacted, and consideration of all these and drafting of the bill will naturally take time. The scheme worked out by the Drugs Enquiry Committee for the organisation, registration and training of this profession though it might need a small preliminary expenditure should eventually be self-supporting.

As regards the machinery to test medicinal preparations, this consists of a well-equipped central laboratory with competent staff of experts in various branches as well as provincial laboratories working under the guidance of the central laboratory. This part of the scheme undoubtedly needs an initial outlay and recurring expenditure. In actual practice, however, it will not be necessary to start with the complete scheme as drawn up by the Drugs Enquiry Committee at once so that the expenditure will not be very large in the beginning. The full scheme will take 3–5 years to develop and it will only be necessary to make a modest beginning which will not necessitate very great expenditure. By the time the scheme matures, a certain amount of revenue will be coming in and there is no reason why eventually the scheme should not be self-supporting or very nearly so.

So far as the Provincial Governments are concerned the scheme will also not be very expensive, as alarmists have suggested that it will be. With very little extra expenditure, the existing provincial laboratories could be so strengthened as to undertake the ordinary testing of drugs for the purpose of control. For complicated drugs they will have the central laboratory to utilise. We have no doubt that addition of two or three trained men, with modest salaries, to the existing staff of the provincial laboratories will be all that is necessary to carry out the work which will fall on these laboratories for several years to come. So far as the provision for the inspecting staff is concerned, the Drugs Enquiry Committee preferred the appointment of special drug inspectors not attached to any particular department. If, however, the appointment of these whole-time inspectors is too expensive under the present state of finances, the work can, for some years to come, be entrusted to the inspectors of the Excise Department. Little or no extra remuneration need be given to these officers, while the scheme is maturing the work thrown on them will be very light indeed. Later, when the whole scheme matures and revenue begins to come in from registration, licensing and fees for testing drugs, separate inspectors may be appointed.

The important point emphasised in the Report of the Committee, with which we emphatically agree, is that in any scheme of control the Central Government as well as Provincial Governments must take part. No system of control in which the Provincial Governments do not take their due share along with the Central Government will be feasible, or workable so that the responsibility lies on the heads of both. Public health is a transferred subject and the local legislators will be lacking in their duty if they do not realise their responsibility regarding drug control and let things continue as they are at present.

Isolation and Properties of Pepsin and Trypsin.

By John H. Northrop.

(*The Rockefeller Institute for Medical Research, Princeton, N. J.*)

ONE of the most striking characteristics of living things is the rapidity and precision with which the chemical changes necessary for their existence are carried on. The process of digestion is a familiar example. Proteins are split in the stomach into much smaller compounds, and this process is continued in the small intestine. The final products are precisely those needed for the nutrition of the animal and are formed from proteins with little or no evolution of heat or expenditure of energy. The process cannot be duplicated without the aid of enzymes since chemical hydrolysis of proteins yields different products and in any case can be accomplished only by violent treatment and the expenditure of considerable energy. Similar examples of the efficiency of the reactions which take place in the animal could be multiplied indefinitely. It is now known that these specific accelerating effects which living cells exert on the reactions occurring within them and in their vicinity are due to the presence of minute amounts of some substances formed by the living cell which have come to be known as enzymes. Without enzymes life could not exist and yet enzymes themselves are not living.

For many years this characteristic ability of living matter to direct these reactions was regarded as a vital activity entirely outside the realm of experimental science. Evidence gradually accumulated, however, to show that the living cell was not necessary, for some, at least, of these characteristic reactions; and one case after another was found in which the reaction could be made to take place without the living cell. But it was not generally admitted that only the enzyme was essential rather than the living cell itself until Buchner discovered that fermentation of sugar could be caused by yeast extract containing no living cells.

It had been suspected long before Buchner that the process of gastric digestion was due to the presence of some specific substance. Schwann in 1836 definitely assumed the existence of such a substance and named it "pepsin". The existence of trypsin in the intestine had also been suspected early in the nineteenth century, but was not definitely assumed to exist until the time of Corvisart (1857) and of Kühne (1867), who gave it its present name. A large number of other enzymes were then discovered by means of their characteristic reactions. It was assumed that since the reactions occur, enzymes must exist to cause them, but there was no direct proof of the actual existence of enzymes, and, in fact, their existence as ordinary chemical compounds has been frequently questioned. The problem is analogous to that of the causative agent of an infectious disease. A causative agent is assumed to exist because the disease occurs, but the assumption cannot be proved until the etiological factor is actually isolated.

During the time enzymatic processes were being discovered the chemists found that many purely chemical reactions are accelerated by small amounts of substances which apparently are not changed by the reaction. Berzelius pointed out that the properties of these substances are strikingly similar to those of the active agents found in living cells. He named the general phenomenon catalysis and considered what are now called enzymes to be a special class of catalysts.

The name "enzyme" was proposed by Kühne for these organic catalysts. In the last fifty years enzymes and enzymatic reactions have been studied intensively by chemists and physiologists. The chemists have been interested primarily in the mechanism of the reactions and the physiologists in the nature of the reactions, and both chemists and physiologists have spent a great deal of time trying to isolate the enzymes. Rapid progress was made in the study of the nature of the reactions caused by enzymes and in many cases the kinetics of the reactions were found to agree with chemical theory but the nature of the enzymes themselves remained quite unknown for many years.

In the last nine years the chemical nature of several enzymes has been determined; urease (Summer), pepsin (Northrop), trypsin (Northrop and Kunitz), amylase (Caldwell, Booker and Sherman), chymo-trypsin (Kunitz and Northrop), yellow respiratory ferment (Warburg and Theorell) and carboxy polypeptidase (Anson) have been obtained in crystalline form. These preparations are all proteins, and this result agrees with

much of the earlier indirect evidence concerning the nature of enzymes. The general chemical nature of these enzymes is therefore known. Enzymes have powerful catalytic properties, however, not possessed by ordinary proteins and hence must possess characteristic chemical structures not found in ordinary proteins. This characteristic chemical structure must be determined before the enzyme problem is completely solved.

ISOLATION AND CRYSTALLIZATION OF PEPSIN.

Nearly all attempts to isolate enzymes have been carried out with relatively small quantities of material in rather dilute solution. Adsorption methods have been extensively used. If enzymes really are proteins, these are not favourable procedures for their isolation, since proteins are extremely unstable in dilute solution and are easily injured by adsorption on surfaces. The attempt to isolate pepsin was undertaken from the point of view of protein chemistry using only those conditions under which proteins are relatively stable, *i.e.*, in concentrated solutions and at low temperature. Purification was accomplished by precipitation with ammonium or magnesium sulphate at various hydrogen ion concentrations and temperatures.

The method was based originally on that of Pekelharing who had described the isolation from gastric juice of an amorphous protein which had powerful proteolytic activity. The last step in Pekelharing's preparation consisted in dialysing a protein fraction from gastric juice against dilute acid. Under these conditions a white precipitate is formed which is a protein and which contains most of the activity. This protein sometimes appears in a somewhat granular form and under the microscope looks as though it might be trying to crystallize. Many attempts were made to crystallize the protein without success. It was noticed finally that this precipitate dissolved if the suspension were warmed to 37° C. and reappeared again upon cooling. These are good conditions for the formation of crystals, and the experiment was repeated under varying conditions and especially with more concentrated solutions, since crystallization in general occurs more readily from concentrated than from dilute solutions. A more concentrated suspension than usual was warmed to 37° C., and the solution was allowed to cool slowly to room temperature in a beaker. The next morning it was found to contain several grams of beautifully formed crystals in the form of double, six-sided pyramids. They were tested for activity and found to be highly active and also to be protein (Fig. 1).

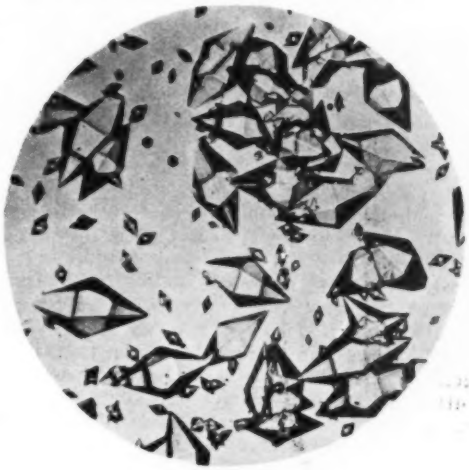

Fig. 1.
Pepsin.

Only small amounts of the crystalline material could be obtained by the original method, but it was found possible to modify it and eventually to dispense with the dialysis which is the most troublesome part of the method. The crystalline protein can now be prepared from commercial pepsin preparations simply by precipitation with magnesium sulphate and then with dilute sulphuric acid. The protein crystallizes very readily, in fact much more readily than most proteins and it is easily possible to prepare 100 gm. in 2 days. A method is therefore at hand by which large quantities of a crystalline protein having powerful proteolytic activity can be prepared. The crystalline enzyme has also been prepared from bovine gastric juice (Northrop). Pepsin prepared from bovine gastric juice differs from, but is very similar to, that from pig gastric extracts. The two enzymes may be distinguished by solubility measurements. It is probable, therefore, that the various pepsins differ from species to species, as do the hemoglobins.

ISOLATION OF CRYSTALLINE TRYPSIN FROM ACTIVE PANCREATIC EXTRACTS.
(Northrop and Kunitz.)

Kühne considered that one enzyme of

the pancreas could hydrolyse protein completely to amino acids and called this hypothetical enzyme "trypsin". He showed that the pancreatic juice itself was inactive and only became active on reaching the intestine. The inactive form of the enzyme was named "trypsinogen". It is now known that the complete hydrolysis of proteins is due to a group of enzymes [erepsin (Cohnheim), aminopolypeptidase, carboxypolypeptidase, protaminase and probably others] so that the original "trypsin" does not exist. The name, however, has always been associated more especially with the enzyme which is activated by intestinal extract and digests proteins (Schepowalnikow). The name "trypsin" has been retained, therefore, to designate what appears to be the most important proteolytic enzyme of the pancreatic juice. This enzyme is present in fresh pancreas in an inactive form, trypsinogen, which is transformed into trypsin by intestinal extract or by allowing the pancreas to stand in slightly acid solution.

The methods used in the isolation of trypsin were, in general, similar to those used in the isolation of pepsin. The raw material was obtained by allowing frozen pancreas to thaw and collecting the expressed fluid. This fluid contained the active form of the enzyme. The problem of purification turned out to be a difficult one, and a great deal of work was done before any encouraging results in the way of either a crystalline product or a product of constant activity was obtained. The most promising method seemed to be precipitation with ammonium sulphate. A protein fraction was eventually obtained which had constant activity and gave some indication of crystallization. The work was made difficult by the very unstable nature of the protein. This unfortunate property made it impossible to allow a solution to stand for more than a few hours, so that the usual procedure for crystallization, which consists in allowing a solution to concentrate or cool very slowly, could not be used. After a large number of unsuccessful attempts, Dr. Kunitz was able to secure definite, regular crystals by the very cautious addition of strong ammonium sulphate to rather concentrated solutions of the protein. The crystals are rather small and are of the cubic system. The proof that this material is a pure substance is still more difficult than in the case of pepsin, since it is more unstable.

ISOLATION OF CHYMO-TRYPSINOGEN, CHYMO-TRYPSIN, TRYPSINOGEN AND TRYPSIN FROM INACTIVE PANCREAS.

The method of isolation described above was laborious and somewhat uncertain since preparations were occasionally obtained which could not be crystallized. It seemed probable that trypsinogen, the inactive form in which the enzyme exists in fresh pancreas, was more stable and hence more easily handled than the active trypsin. The attempt was therefore made to isolate this inactive form of trypsin from fresh pancreas. It was found in the earlier trypsin experiments that the enzyme was remarkably resistant to acid while much of the other protein material present in pancreatic extracts was denatured by acid. Fresh pancreas was, therefore, extracted with strong acid and it was found that most of the inert material remained insoluble while the enzyme was dissolved and extracted. Extraction with strong acid yields a solution which is much more easily purified than those obtained with glycerin, bicarbonate or after autolysis. These latter methods are the ones which have been used in other attempts to isolate trypsin. The results obtained in the present work are largely due to the use of acid extracts. This extract remains inactive indefinitely but is rapidly activated by extract of small intestine (enterokinase) at pH 8·0.

Isolation of chymo-trypsinogen and chymo-trypsin.—The acid extract was fractionally precipitated by ammonium sulphate and a crystalline protein obtained from the fraction precipitated by 0·7 saturated ammonium sulphate (Fig. 2). This protein had no enzymatic activity and could not be activated by kinase. It was considered at first to be merely an inert protein but it was soon found that traces of trypsin would convert the protein into a powerful proteolytic enzyme which differed from the usual trypsin preparation in that it clotted milk. This enzyme probably represents Vernon's "pancreatic rennet" and was called "chymo-trypsin". This active form of the enzyme was also crystallized (Fig. 3).

Isolation of trypsinogen and trypsin.—The mother liquor from the chymo-trypsinogen still becomes active upon the addition of kinase or upon the addition of strong magnesium or ammonium sulphate to a neutral solution, and so still contains

Fig. 2.
Chymc-trypsinogen.

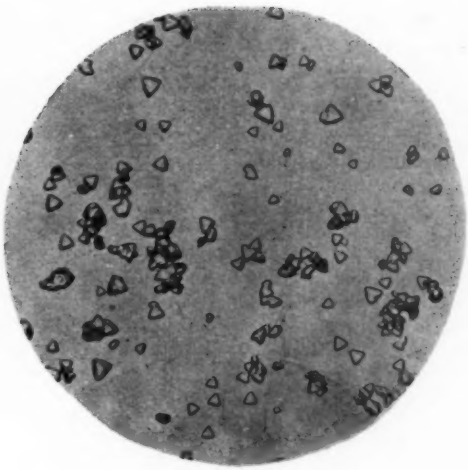

Fig. 4.
Trypsinogen.

Fig. 3.
Chymo-trypsin.

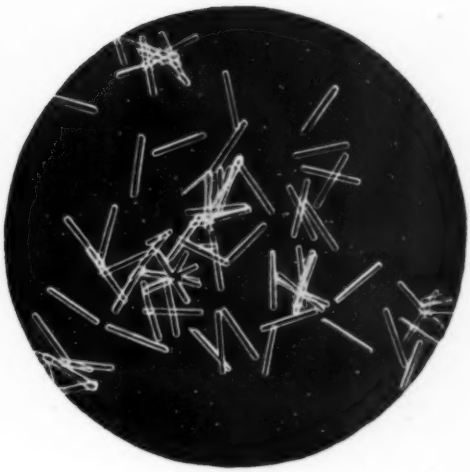

Fig. 5.
Trypsin.

inactive trypsin. The inactive trypsin (trypsinogen) was crystallized from magnesium sulphate solution pH 8·0 at 6° C. in the form of short triangular prisms (Fig. 4). Recrystallization was undertaken and appeared to proceed normally but upon examination the crystals were found to be long square prisms instead of triangular prisms and to be active instead of inactive (Fig. 5). They resembled slightly the crystals of trypsin previously prepared from active material and turned out to be identical with this earlier preparation. Material prepared by the earlier method also crystallizes in the same long square prisms under these conditions.

The transformation of the inactive form of the enzyme during recrystallization is due to the fact that the conditions for crystallization are the same as those for activation. Also, the crystallized trypsinogen activates much more rapidly than does the crude product. This peculiarity is

discussed later in connection with the mechanism of activation.

ISOLATION AND CRYSTALLIZATION OF CARBOXYPOLYPEPTIDASE.

Active pancreatic extracts contain an enzyme which splits certain amino acid compounds in such a way as to liberate an amino acid which, in the intact compound, has a free carboxyl group. This enzyme was named carboxypolypeptidase by Waldschmidt-Leitz. Anson has recently isolated and crystallized this enzyme from active pancreatic extracts (Fig. 6). The enzyme

Fig. 6.
Carboxypolypeptidase.

is a globulin and may be recrystallized without change in activity or other properties. It acts in the presence of strong formaldehyde and differs in this respect from the other proteolytic enzymes of the pancreas.

EVIDENCE THAT THE ACTIVITY IS A PROPERTY OF THE PROTEIN MOLECULE.

Tests of purity.—The experiments just described show that crystalline proteins having intense proteolytic activity may be isolated from gastric or pancreatic extracts. It is an experimental fact that these preparations are crystalline proteins but it by no means follows directly that the enzymatic activity is a property of the protein molecule. If it could be shown that the preparations are pure substances it would, of course, follow that the activity must be due to the protein but it is unfortunately extremely difficult to prove the purity of proteins. The usual criterion of purity is constant composition and properties after repeated crystallization and these preparations fulfil that criterion.* Solubility measurements furnish one of the most sensitive tests for mixtures and careful solubility measurements were done with crystalline pepsin. The results showed no evidence of more than one chemical compound. Diffusion experiments showed that the rate of diffusion of the active molecule was exactly the same as that of the protein, proving that the two molecules must be the same size at any rate, if not identical. If an inert protein, such as edestin, is stirred in a solution of pepsin the enzymatic activity is taken up by the foreign protein and at the same time an exactly equivalent amount of pepsin protein is taken up. Pepsin, trypsin and chymo-trypsin, under certain conditions, are transformed into denatured, insoluble proteins. At the same time there is a corresponding loss in activity. The denatured protein may be changed back to the native, soluble form and when this is done the activity returns. If the proteins are denatured by ultra-violet light there is also a corresponding loss in activity and the wave-length which is most efficient in denaturing the protein is also the most efficient one in destroying the activity (Gates).

Trypsin may be digested by pepsin and in this case again the loss in tryptic activity is just proportional to the amount of trypsin protein hydrolysed. The same experiment may be performed with chymo-trypsin and pepsin or with pepsin alone in strong acid solution. The foregoing experiments indicate strongly that these crystalline proteins possess enzymatic activity and the next problem is to determine what particular chemical structure in the protein is responsible for this remarkable property.

Acetylation of pepsin (Herriott) has furnished some evidence in this connection. A crystalline acetyl derivative was isolated which contains 3 or 4 acetyl groups attached to the primary amino groups (Fig. 7). This derivative has the same activity as the original pepsin. A second crystalline derivative containing 7 acetyl groups has also been isolated (Fig. 8). It has 60 per cent. of the activity of the original pepsin. The four additional acetyl groups which decrease the activity are probably attached to the hydroxyl group of tyrosine.

Fig. 7.
Four acetyl (100 per cent. active) pepsin.

Fig. 9.
Inhibitor-trypsin compound.

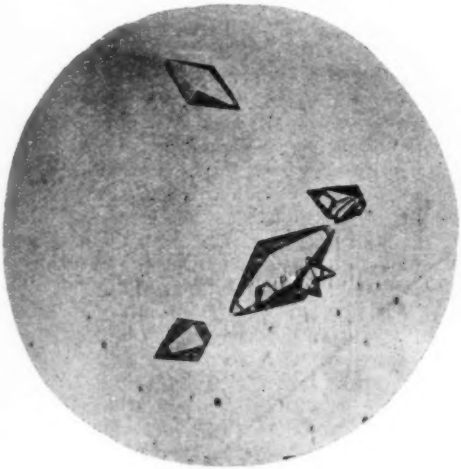

Fig. 8.
60 per cent. active acetyl pepsin.

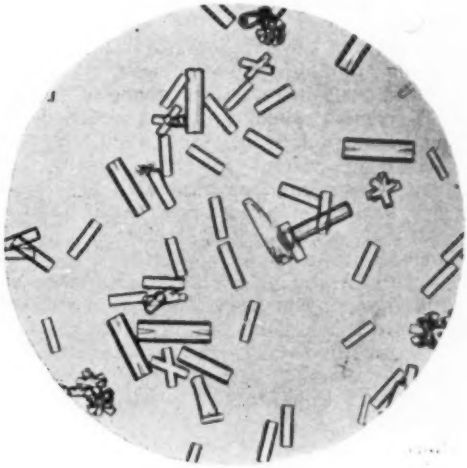

Fig. 10.
Inhibitor.

Evidently, therefore, the primary amino groups, which are presumably on the lycine, have no connection with the structure responsible for the activity, whereas the tyrosine is closely connected with the essential structure.

ACTIVATION OF TRYPSINOGEN.

Kühne and Heidenhain showed that fresh pancreatic juice has no proteolytic activity and only becomes active when mixed with a secretion of the small intestine. Vernon claimed that under certain conditions the activation was caused by trypsin itself, *i.e.*, the activation was autocatalytic, but this conclusion was denied by most subsequent workers. Isolation of the inactive form of trypsin has made possible a study of its activation. It has been found that in neutral solution the reaction is quite strictly autocatalytic, *i.e.*, the transformation of trypsinogen to trypsin is caused by the presence of trypsin itself. Trypsin, therefore, is an example of a molecule which may be

propagated since the inoculation of a solution of trypsinogen with trypsin gives rise to a very large quantity of trypsin and this process may be repeated indefinitely. In the crude extract this reaction is prevented by the presence of a substance which inhibits trypsin activity. A compound of this inhibitor and trypsin has been isolated and crystallized (Fig. 9). It may be separated into its constituents by treatment with trichloracetic acid. The trypsin precipitates and the inhibitor may be crystallized from the trichloracetic acid solution (Fig. 10). It has the general properties of a peptone and a molecular weight of about 6,000.[1]

[1] Summary of a paper presented before The Harvey Society, New York City, May 16, 1935.

Locust Research in Nigeria.

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INTRODUCTION.

BEFORE describing the locust research carried out by the entomological section of the Agricultural Department during the last five and a half years, it is necessary to give a brief account of the various species of locusts which occur in Nigeria.

Swarms of the Tropical Migratory Locust, *Locusta migratoria migratorioides*, R. and F., entered the south-western corner of Nigeria in December 1929, and had reached the Northern frontier by April 1930. Swarms have been present in this country ever since the original invasion and, each year, there have been two generations of hoppers.

In July 1930, hopper bands of the Red Locust, *Nomadacris septemfasciata*, Serv., were discovered near Lake Chad. Only one adult swarm has been found at a distance of more than about 12 miles from the lake.

Swarms of the Desert Locust, *Schistocerca gregaria*, Forsk., were present in that part of Nigeria lying to the north of the 12th parallel N. in April and May 1931; but, there is no evidence that *Schistocerca* either bred or caused damage to crops.

Occasional swarms of the Tree Locust, *Anacridium moestum melanorhodon*, Walk., have been reported from the north-western corner of Nigeria; but this species was not responsible for any damage to crops.

EXPLORATION OF SUSPECTED OUTBREAK CENTRES.

In June 1929, an elephant-hunter saw swarms of an unidentified species of locust migrating south-westwards to the central portion of the Nigerian shore of Lake Chad. These swarms settled and bred in this area. The presence of locusts in the Chad area some six months before the main invasion occurred led to Chad being regarded as a possible outbreak centre of *Locusta*. The discovery of numerous bands of *Nomadacris* hoppers in the southern half of Nigerian Chad in 1930 was the first record of the mass occurrence of the Red Locust in West Africa. As there was no evidence that swarms had migrated to Chad from the outbreak centre south of the equator it seemed probable that the bands were derived from solitary individuals locally.

In October and November, 1931, a preliminary survey was made of the shores of Nigerian Chad. It was found that *Nomadacris* was confined to the southern half of the shore and was associated with a tall grass, *Cymbopogon giganteus*, Chiov., which is absent from the northern part of the lake shore. *Locusta* adults of phases *solitaria* and *transiens* (*dissocians*) were found near the northern frontier and in the southern part of the shore. In June and July each year, *Locusta* swarms arrive from the south-west and breed in the Chad area, so it was impossible to say whether the solitary adults were derived from hoppers surviving the anti-hopper campaigns of 1930 and 1931 or, were the descendants of a permanent *solitaria* population. During the survey a site for a laboratory was selected at Kalkala near the south-western corner of the lake.

During the first six months of 1933 an ecological survey was made of the twelve square miles surrounding Kalkala. From January to April, the *Nomadacris* adults remained in *Cymbopogon* and other tall grasses. Shortly before the rains began in mid-May they commenced to spread from the tall grass areas into short grass and open farmland. Copulation was first

observed on June 20th. Phases *solitaria* and *transiens* (*dissocians*) of *Locusta* were present until mid-March though the number of individuals of both was small. From mid-March to the end of May only *solitaria* was present. Burning and grazing of the grass continually disturbed the locusts which were almost annihilated by Carmine Bee-eaters (*Merops nubicus nubicus*).

It was concluded that the Chad area is unlikely to be an outbreak centre of *Locusta* and that it was probable that conditions there are unsuitable for the production of the gregarious phase of *Nomadacris*.

The ecological survey at Kalkala was continued from September 1933, to January 1934, and from May to October 1934. In addition, a survey was made of a large section of the northern shore which had not been examined in 1931. As a result of this work it was concluded that the region from Kalkala eastwards to the French Cameroun frontier was probably merely the western fringe of a potential outbreak centre of *Nomadacris*. The Red Locust was found to absent from the northern half of British Chad and it was considered that conditions were unfavourable in that part of the southern shore lying to the north of Kalkala. Breeding began on June 1st, 1934. and oviposition was observed on the 16th of that month. As a result of a drought from mid-June to mid-July few hoppers emerged, and the Red Locust reverted to the solitary phase in the Chad area.

An interesting feature of this study was the discovery of *Nomadacris* adults in late October 1934, in areas some 30 miles to the south of the lake.

In May 1935, an entomologist was attached to a French locust mission and the southern shore of Chad was explored from the French Cameroun frontier eastwards to the south-east corner of the lake. Not a single specimen of *Nomadacris* was seen and the wooded character of this part of the shore makes it highly improbable that it is an outbreak centre of the Red Locust. At the conclusion of this work, a visit was paid to Kalkala and it was found that the solitary phase of *Nomadacris* has now become extremely rare in that district. It is possible that the energetic locust campaigns of 1930 and 1931, when about 20 Europeans were engaged in control work in the Chad area, prevented *Nomadacris* from attaining the swarming phase.

From April to September 1932, an entomologist explored the outbreak centre of *Locusta* in the Middle Niger region of French Soudan. The results of this work have not yet been published. The area was subsequently examined by a French locust mission.

FUTURE RESEARCH WORK.

In the near future it is proposed to examine certain marshes in the Bornu and Adamawa Provinces in order to determine the range of *Nomadacris* in Nigeria. It is possible that one or more of these marshes may prove to be a potential outbreak centre.

Every year it is proposed to visit the Chad area with the object of observing the *Nomadacris* population and of organising an anti-hopper campaign should there be any sign of transition from the solitary to the gregarious phase. After *Locusta* has reverted to the solitary phase, these annual visits will afford an opportunity of determining whether this species exists in the Chad area during the intervals between outbreaks.

THE EFFECT OF CLIMATE ON MIGRATION AND BREEDING.

Monthly maps showing the movements of *Locusta* swarms in Nigeria have been prepared since the beginning of the infestation in 1929. The swarm movements are studied in conjunction with climatic factors. As a result of such a study (for the first 17 months of the infestation) an entomologist concluded that with very few exceptions, swarms remain where the mean relative humidity (9 a.m., L.M.T.) is not more than 85% and not less than 40%. This worker also studied the effect of climate upon breeding and concluded that breeding does not commence after the dry season until the humidity rises to 65% and the degree of wetness (total monthly rainfall $\times$ number of days on which rain fell $\div$ 10) reaches 2.

A similar study is now being made of the data available for the first five years of the infestation.

Other branches of research are the biometrical study of adult locusts and the testing of various poisoned baits for use against hopper bands.

Quality in Foods.

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and
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IT has long been recognised that agricultural products can be characterised by certain properties which can be collectively described as quality. In some cases the quality can be defined in terms of certain physical characters such as size, shape, colour or behaviour on milling or cooking. In others, it depends largely on properties such as taste and flavour which are rather difficult to define but are, nevertheless, quite real. In recent years there has also been increasing realization of the importance of constituents such as vitamins, proteins, calcium and phosphorus which are so essential to nutrition and, in consequence, are of great value in assessing the quality of food. As articles possessing the right quality are in great demand and fetch good prices, it is naturally of considerable interest, both to the producer and to the consumer, to determine the nature of the factors that determine quality and the conditions that favour its development.

The scientific study of the subject of quality was not taken up seriously until recent years. This was largely due to (*a*) want of adequate technique to measure the various subtle characters that make up quality, and (*b*) considerable amount of individual variations in regard to requirements of qualities such as taste and flavour. Progress in this line has, in consequence, been comparatively slow. Some useful results have, nevertheless, been obtained and the object of the present article is to make a brief survey of the more important findings and to indicate some of the more promising lines of future research.

Before taking up a discussion of the subject it may be useful to cite a few instances of quality in agricultural as well as horticultural crops. In the case of wheat, the milling quality is greatly valued. Recent enquiries (Bailey[1]) have shown that this is traceable not only to the variety of the grain but also to the nature of the soil on which the crop is grown and the manurial treatment which it receives. Thus, wheat grown on a heavy soil is generally 'stronger' than that raised on a light one. Likewise wheat grown in dry regions is 'stronger' than wheat grown in wet ones. High nitrogen content of the soil or application of nitrogenous fertilisers leads to increase in the nitrogen content of the grain and improved milling quality (Lawes and Gilbert,[2] Bailey, *loc. cit.*). Almost the reverse of the above is observed in the case of malting barley. Heavy soils may give good yields and even enrich the grain with nitrogen, but only the light soils yield grain of the desired quality—rich in carbohydrates but poor in regard to proteins. Application of nitrogenous fertilisers in more than moderate doses leads to diminution in quality (though the yield may increase) and consequent fall in prices.

In the case of tubers like potato and mangold-wurzel, heavy manuring leads to greatly enhanced yields but the quality of the produce suffers considerably. The tubers contain large amounts of water and partially assimilated salts, and, in consequence, possess (*a*) poorer keeping quality and (*b*) lower feeding value than those raised on similar, but unmanured or moderately manured areas.

Fruit crops generally do well on light soils, but the resulting quality is not so good as that obtained from heavy ones. Thus, a comparison of apples of the same variety grown on adjoining clay and light soil show that the fruits from the former are smaller and more green, but possess a greater proportion of sugar, acid and aroma than those from the latter. It is also the general experience of fruit growers that manures which act slowly but steadily (like farmyard manure) yield fruits of better taste and flavour than those receiving concentrated fertilisers which act rapidly.

It is a matter of common experience that market garden crops (such as cabbage), grown on mineral fertilisers, though developing to much bigger sizes, contain very much more water and perish more readily than those raised on unmanured or moderately manured soil. It has also been recently suggested that grain and fodder crops treated with organic manures are richer in regard to

[1] Bailey, C. H., *The Chemistry of Wheat Flour*, The Chem. Catalog. Co., Inc., 1925.

[2] Lawes, J. B. and Gilbert, J. H., *J. C. S.*, 1884, **45**, 305.

vitamins and other growth-promoting factors than those receiving mineral fertilisers (Anon[3], McCarrison,[4, 5] Kottmeier,[6] Viswa Nath and Suryanarayana,[7] Breazale,[8] Krüger,[9, 10] Hunt,[11] Rowlands and Wilkinson,[12] Sirachenko[13] and Viswa Nath[14]).

The factors that contribute towards quality in beverages such as coffee, tea, cocoa, beer and wine, as also spirituous liquors such as brandy and whisky, have been the subjects of a number of researches in recent years. As the result of these enquiries, it is now recognised that, in addition to varietal differences, a number of external factors such as, altitude, soil conditions, manuring, period of rainfall, composition of the water used for brewing, the composition of the container—all contribute towards the collective impression of quality which is evaluated by the specialist taster. It is true that tasters are not infallible but it has, nevertheless, to be admitted that, in most cases, their judgment is not only reproducible by independent opinion but is also supported by popular favour.

Taste is made up of a number of components among which salinity, sweetness, sourness or pungency as the case may be, are no doubt the most dominant. There are also other subtle features to which the specialised human tongue is sensitive but which cannot be easily evaluated in terms of known chemical constituents. It is true that among the non-specialists, especially those indulging in excesses of certain kinds of foods, narcotics or beverages, tastes do not always agree and may even be quite opposed to one another. Thus it is known that one addicted to strong drinks, especially of the cheaper type, cannot make out the subtle distinctions in taste and flavour between the different brands of whisky or brandy; still less can he evaluate the lighter beverages which require an even more sensitive palate. On the other hand, the opinion of connoisseurs has invariably supported the evaluation of specialist tasters whose verdict determines, to a large extent, the prevailing market prices. It is necessary, therefore, that the producer should not only have further knowledge of the nature of the factors contributing to taste but also of the external conditions which determine them. By adequately controlling the latter, the taste of the produce can be improved with increased monetary returns to the producer.

Flavour is very much more difficult to define. It is generally associated with taste. The main constituents of flavour are often of the nature of volatile substances, but they do not contribute the entire effect. It is within the scope of the organic chemist, however, to identify the nature of the subtle constituents producing the desired effect, and, if necessary, even supply them in suitable proportions to substances lacking in them. It is also known that edaphic and other factors similar to those affecting taste also influence flavour, though to a different degree. It should be possible to define, more carefully, the nature of the relation between these factors, and even alter them, so as to obtain the desired flavour, which is often so highly prized.

In recent years, much valuable information relating to the quality of malting barley and its bearing on the brewing industry has been obtained. Thanks to the efforts of the Research Fund Committee of the Institute of Brewing, considerable progress has been made in devising and perfecting laboratory technique, and there is every prospect of it soon being possible to replace experimental maltings by rapid laboratory analyses.[15] The importance of the nitrogen content of the cereals in the brewing industry has been recognised more or less clearly ever since scientific methods were first applied (Munro and Beaven,[16] Beaven[17]). It is known that the nitrogen compounds act as dilutents of the carbohydrates of the grain and hence reduce the available extract; they also serve as essential aliments for the micro-organisms concerned and govern, to some extent, the enzymic activity; further, high nitrogen in

[3] Anon., *Science*, 1921, **54**, 469.
[4] McCarrison, R., *Brit. Med. Jour.*, 1924, **1**, 567.
[5] McCarrison, R., *Ind. Jour. Med. Res.*, 1926, **14**, 351.
[6] Kottmeier, *Kuhn. Archiv. Berlin*, 1927, **15**, 25.
[7] Viswa Nath, B. and Suryanarayana, M., *Mem. Dept. Agric. India, Chem. Ser.*, 1927, **9**, 85.
[8] Breazale, *Univ. of Arizona, Tech. Bull.* No. 16, 1927.
[9] Krüger, E., *Landw. Jahrb.*, 1927, **66**, 781.
[10] Krüger, E., *Bied. Zentr.*, 1928, **57**, 156; cited from *Chemistry and Industry*, 1928, **47**, 583.
[11] Hunt, G. H., *Ohio Agric. Expt. Stat.*, 45th Annual Report, 1928.
[12] Rowlands, M. J. and Wilkinson, B., *Biochem. Jour.*, 1930, **24**, 199.
[13] Sirachenko, I. A., cited from *Chem. Abstr.*, 1931, **25**, 3116.
[14] Viswa Nath, B., *Ind. Jour. Agric. Sci.*, 1931, **1**, 495.
[15] Rothamsted Conferences VII. Malting Barley. Ernst Benn Ltd. (1928).
[16] Munro, J. M. H. and Beaven, E. S., *J. Roy. Agric. Soc.*, 1897, **58**, 65; 1900, **61**, 185.
[17] Beaven, E. S., *J. Inst. Brewing*, 1902, **8**, 542.

barley leads to malting loss by both increased respiration and rootlet growth and also to difficulty in modification. Quality in beer depends on several factors like flavour, colour and aroma and is in the main determined by conditions of malting, hopping and fermentation. The majority of recent investigators agree that head retention, palatefulness and both colloidal and biological stability are largely dependent on nitrogenous substances derived from the original protein constituents of the barley. The maltster prefers low nitrogen barleys because they modify more readily and have a lower "malting loss", whilst the brewer knows that they give higher extracts, and, he believes, bright and relatively stable beers. The effect of these preferences has been shown by the high valuations generally placed on low-nitrogen barleys in the market. On the other hand, it has been suggested that such barley may be deficient in enzymic activity, yeast feeding material and those nitrogenous substances which are mainly responsible for palate fulness and head retention (Cluss[18], Stadler[19]). Bishop's work[20] would suggest, however, that, within one variety, the total quantity of nitrogen in barley and its quality may not be so unrelated as has been supposed by some. It is already possible to connect, quantitatively, certain factors in the brewing value of barley with nitrogen content. From a statistical analysis of some of the results obtained for barleys and malts in the course of his research, Bishop[21, 22] has derived a formula which may be used to predict the yield of extract which should be obtainable from any given sample of barley, when malted under normal conditions. This formula is based on a knowledge of the nitrogen content, moisture and thousand-corn weight of the barley. Chemical analyses are thus assuming a fundamental significance and already workers (Bishop,[23] Steven,[24] Russell and Bishop, *loc. cit.*) are studying the cultural conditions on which the various factors depend.

Breadmaking is one of the most ancient of industries, but scientific control of the various processes is not yet a feature of standardised procedure. Mass production of such an article as bread, demanding close attention to temperature, fermentation conditions and time factors, as well as a recognised standard of public taste, necessitates an intimate knowledge of "what happens". At the Symposium on Bread and Milk held in 1933 under the auspices of the Food Group of the Society of Chemical Industry, there were presented a number of communications (Jørgensen,[25] Brabender,[26] Eyre,[27] Jago[28] and Kent-Jones[29]) which related to the control of wheat so as to produce the best flour and of flour so as to produce the best bread and the forecasting of the value of flour in practice by laboratory tests. It is of course realised that wheats grown in different parts of the world yield flours of very different baking qualities. The development of elastic properties and of distensibility in dough during leavening are the most important quality factors of flour. Bakers naturally prefer what is popularly designated "strong" flour. This strength is rather difficult to define, but it may be stated that it is a condition which facilitates the making of bold, upstanding loaves of good texture. The demand for strong wheat cannot always be easily met. Fortunately, it was found that flour improved in strength and baking quality if it was stored for some time. Later on, it was found that minute quantities of certain chemicals (such as one part of persulphate in 15,000 to 20,000 of flour) produced effects as good as, if not better than, those given by long storage. The most widely used "improvers" at present are ammonium persulphate, potassium bromate or mixtures of chlorine and nitrogen trichloride. It is generally believed, however, that such treatments destroy flavour and that the craze for increased yield per acre has resulted in wheats of poor flavour.

The Food Group Symposium (*loc. cit.*) was also productive of valuable contributions (Kay,[30] Wilson,[31] Drummond[32] and Minett and Pullinger[33]) surveying the improvements

[18] Cluss, A., *J. Inst. Brew.*, 1929, **35**, 426.
[19] Stadler, H., *Woch. Brau.* 1929, **46**, 479.
[20] Bishop, L. R., *J. Inst. Brew.*, 1928, **34**, 101; 1929, **35**, 16.
[21] Bishop, L. R., *J. Inst. Brew.*, 1930, **36**, 421.
[22] Russell, E. J., and Bishop, L. R., *ibid.*, 1933, **39**, 287.
[23] Bishop L. R., *J. Inst. Brew.*, 1930, **36**, 353.
[24] Steven, A., *Zeit. Pflanz. Düng.*, 1930, **9B**, 35.
[25] Jørgensen, H., *J. S. C. I.*, 1933, **52**, 382T.
[26] Brabender, C. W., *ibid.*, 1933, **52**, 375T.
[27] Eyre, J. V., *ibid.*, p. 406T.
[28] Jago, W., *ibid.*, p. 412T.
[29] Kent-Jones, D. W., *ibid.*, p. 409T.
[30] Kay, H. D., *J. S. C. I.*, 1933, **52**, 363T.
[31] Wilson, G. S., *ibid.*, p. 403T.
[32] Drummond, J. C., *ibid.*, p. 401T.
[33] Minett, F. C. and Pullinger, E. J., *ibid.*, p. 379T.

which have been made in milk supply of recent years, and pointing out how very desirable it is that quality of milk should be raised, even at the expense of quantity, by systematic breeding. The development of "off" flavours and other defects in butter has long exercised the minds, not only of the traders, but also of scientific workers. In this connection, the effect of wrapping materials, alleged to be the cause of taints and of the development of tallowy flavour, as also the nature of the factors causing auto-oxidation of the fats, are being investigated (Davies[34]).

The cooking qualities of different specimens of *dhal* (red gram or pigeon pea, *Cajanus indicus*) vary considerably, some requiring long continued boiling to reach the desired stage, whilst others cook quickly and the object of the purchaser is naturally to acquire the latter type. Apart from the cooking qualities, it is generally found that the quality of the water used for boiling has a considerable effect upon the rate of cooking. Indeed, as has been shown by Viswa Nath *et al.*,[35] the rate of cooking depends upon two factors, namely, the amount and the kind of dissolved substances present. With neutral salts, the effect is a general retardation, whereas in the case of alkaline salts, the rate of cooking is accelerated; in either case, the effect increases with the salt concentration.

"Bloom" in meat is described as the "freshly killed appearance of the meat" and its preservation is a matter of considerable interest to the producer. The problem of ascertaining how far the conditions of freezing, storage and transport of mutton can be modified so as to improve its "bloom" and general quality has merited close co-operative investigation.[36] Loss of bloom can be closely connected with loss of water by evaporation or by sweating. To diminish loss by evaporation, it is recommended that the carcasses should be enclosed as quickly as possible in bags impermeable to water vapour.

Toughness in meat is another serious problem which has not yet been satisfactorily solved. It is known that, in many cases, prolonged exposure to atmospheric conditions helps to soften the meat and to render it fit for cooking. There are others however which continue indefinitely to be tough and thus prove to be a source of considerable annoyance to the consumers. This defect can be largely overcome by treatment with small quantities of digestive ferments such as papain. Further work is needed however to standardise the conditions in such a manner that every housewife can easily adopt it.

Growers of fruits and vegetables have been confronted with the problem of maintaining a high quality in their produce, of preventing their turning brown or developing unpleasant odour on storage and of reducing their susceptibility to fungal invasion and decay. The National Institute of Agricultural Botany at Cambridge has been doing useful work in estimating the quality of already established varieties of potatoes. The main requirements of the potatoes are that the flesh shall be white, that a minimum amount of discolouration shall be produced when they are boiled or steamed and then reheated. A floury texture is demanded by a vast majority of consumers. It is also important that the potato should have shallow eyes so that it can be peeled easily and without waste. It must also survive storage for long periods and stand transport without damage. When chipped, the outer surface should be crisp and of a rich golden brown colour, while, internally, there should be a layer soft in consistency. In addition, it is generally considered an important point that as little fat as possible should be absorbed in the process of frying. As a result of a large number of trials with tubers cooked under standard conditions, the Institute has been able to show that there is exceedingly little variation in the results of tests carried out at different times; that the same variety grown in different localities shows greater divergences in quality than different varieties raised in the same place; that colour after cooking and, to some extent, consistency of flesh are influenced by soil rather than by season and other factors (Parker[37]). Standard laboratory tests to measure the presence of certain qualities in the potato have also been devised. Thus, Tinkler[38] has recently published a method for determining, chemically, the susceptibility of potatoes to blackening

[34] Davies, W. L., *J. S. C. I.*, 1934, **53**, 117T, 148T.
[35] Viswa Nath, B., Lakshmana Row, T., and Ayyangar, P. A. R., *Memoirs Dept. of Agric. India*, 1916, **4**, 149.
[36] *Food Investigation, Special Report*, No. 41, H.M.S.O., 1931.
[37] Parker, W. H., *J. S. C. I.*, 1932, **51**, 94T.
[38] Tinkler, C. K., *Biochem. J.*, 1931, **25**, 3, 773.

on cooking, while Peacock and Brunstetter[39] have devised a chemical method of determining their suitability for chipping.

Rice is the staple food of hundreds of millions in India and in the East in general. Indeed, among the foods of men, it holds the foremost place, the estimated normal yield being 440 billion pounds of rough rice against 276 billion pounds of the second crop, wheat. More than 35 per cent. of the total cultivated area of India is under rice. There are several thousands of varieties recorded. In addition to this, a large number of new varieties are being added every year as a result of hybridisation between existing varieties.

The ultimate purpose of improvement in rice culture is to obtain grain with good hereditary qualities. Some varieties recommend themselves by high yield, others by good milling properties, keeping quality, fine taste, pleasing appearance, fitness to a variety of soil conditions, resistance to adverse weather conditions, pests and diseases, ease of harvesting and in various other ways. A thorough knowledge of the variations in the different items of qualities in rice is very essential, so that, armed with this knowledge, the breeder can attempt to combine high yields with superior quality.

The yield of head rice comprising the whole kernels is an important item both for the growers and the millers. The factors which contribute to high milling quality in rice are yet ill-defined, though it has been the experience of farmers that great care is needed to stop irrigating in due time and proceed promptly with the harvest. The prominence or otherwise of ridges on the rice kernel, formed as a result of the kernel growing against its case, the hull, would also appear to determine the milling quality of the rice. The less prominent these ribs are, the more suitable the grain is for milling.

From the point of view of the market value of the grain, there is another important quality in rice which finds expression in the appearance and texture of the grain. In common rice, a large part is vitreous (corneous) composed very largely of starch, but it contains also an appreciable amount of albuminoid substance. The more completely vitreous, the harder as a rule is the kernel, and the better the quality as this is usually judged. A part of the endosperm—a very small part in the best commercial rices—is white, opaque and chalky in texture. This part of the endosperm is relatively weak in albuminoids. The corneous rices include the best commercial varieties; they keep and stand shipment better than the usually softer, opaque rices. What is called glutinous rice has uniformly chalky and not very hard kernels. In glutinous rice, the endosperm contains considerable percentage of soluble starch and dextrin besides some maltose. Such rice is sometimes called dextrinous in distinction to starchy. It is called glutinous because it forms a sticky mass when cooked; but no substance which ought to be called gluten is responsible for this behaviour (Tanake,[40] Kikkawa[41]). Glutinous rice is hardly known in many parts of India, but it is greatly favoured in Japan and China. About 8 per cent. of the rice area of Japan is planted with such varieties and in China the estimate is as high as 20–30 per cent. They are largely used for making pastries. It would be of considerable scientific as well as practical interest to determine the nature of the relation between hard, soft and glutinous varieties of rice and to assess their relative nutritive values.

In the commoner varieties of paddy the period lapsing between the germination of the seed and the harvesting of the grain varies from about three to eight months. The ryot chooses the short period crop in anticipation of either (*a*) irrigation facilities for two or more crops in a season or (*b*) unfavourable climatic conditions which might destroy a long-standing crop. It is generally believed that short duration varieties are poorer in quality than long duration ones, because they are assumed to remove less of plant food from the soil. Thus, in South India, short duration *Kuruvai* or *Kar* varieties are not valued so much for their nutritive qualities as the long duration *Samba* varieties. Similarly in Bengal, it is held that *Aus* rice is inferior to *Aman* practically in all respects. Chemical analyses also show that *Aman* varieties are generally richer in protein, fat and potash contents than the *Aus* varieties (Basu and Sarkar[42]). If this belief were true, it would follow that although the farmer loses in total yield by

[39] Peacock, W. M., and Brunstetter, B. C., *U. S. Dept. Agric. Circ.*, 1931, 158.

[40] Tanake, Y., *J. Ind. Eng. Chem.*, 1912, **4**, 578.

[41] Kikkawa, S., *J. Coll. Agric. Tokyo*, 1912, **3**, 108-11.

[42] Basu, K. P., and Sarkar, S. N., *Ind. Jour. Med. Res.*, 1935, **22**, 745.

raising a long period crop, he gains considerably in quality. Scientific evidence to warrant the popular belief that short duration crops are deficient in nutritive constituents is still lacking.

Although in rice-growing lands, the general preference is everywhere for white rice, there are still a great number of recognised varieties of coloured rices deliberately grown, because of distinctive flavour, high yield, or the belief that they are especially nutritious. It is also stated that red rice is generally rich in iron and phosphorus. These have to be verified. The presence of red in the milled rice being itself evidence of incomplete milling, this incompleteness may explain the nutritive value of such rice.

Rice is essentially a water crop. Practically all the rice of commerce is irrigated, as is also by far the larger part of rice locally consumed by all the rice-producing countries. Irrigated rice is, in general, the more productive also. Even those varieties of rices which are cultivated dry are more productive if irrigated. McCarrison[42,43] has adduced evidence to show that the wet crop is poorer in nutritive value than the dry one. If this is found to be generally the case, it would be desirable to extend the method of dry cultivation and, if possible, improve on it so as to combine superior quality with high yield. In this connection, it may be mentioned that silicate fertilisation has been found by the authors to improve the yield of rice under dry-land conditions.

It is well known that rice prepared by husking recently harvested paddy (*a*) cooks rapidly to a shapeless paste and (*b*) causes digestive disorders on being taken. After storage for some time, however, the same rice cooks properly and is easily digested. Apart from the difficulty in husking fresh paddy without breakage, the quantity of cooked rice is very much less in the case of fresh grain than in that stored for some time. The question of storage and its effect on the nutritive value of rice requires investigation. The nature of the chemical changes taking place during storage, as also the significance of such changes in relation to the nutritive value of rice prepared out of them, would require careful scientific study. In practice, some varieties are stored for longer periods than others. Short duration crops generally require longer storage than long duration ones. A systematic study of the conditions relating to the above as also the comparative efficiencies of different methods (Srinivasan[44]) now in vogue would be of much practical interest.

In most rice-growing countries, a part of the annual output of grain—some varieties to a greater extent than others—is subjected to parboiling prior to milling. The paddy is cleaned, then soaked in water for a definite time and afterwards steamed till the outer-coats just begin to burst. The conditions relating to parboiling are highly variable (Srinivasan, *loc. cit.*, p. 59), but, irrespective of this, parboiled rice is generally considered to be more nutritious than raw rice; when cooked, it keeps well for considerable lengths of time, either by itself or soaked under water. Besides, it is claimed to possess greater sustaining power than raw rice. Such rice also mills better (Ishaq[45]). Following the observations of Braddon,[46] Fletcher,[47,48] Ellis[49] and others who observed that people who eat parboiled ("cured") rice generally escape beriberi, several workers (Fraser and Stanton,[50-52] McCarrison and Norris[53]) have investigated the antineuritic value of raw and parboiled rices and shown that samples of parboiled rice, even when milled, protected pigeons from polyneuritis whereas raw polished rice caused the disease. Recently, Aykroyd[54] has shown that parboiled rice contains more vitamin B_1 and has a greater phosphate content than raw rice milled to the same extent. He has made the suggestion that the better nutritive value of parboiled rice is due to diffusion of the vitamin B_1 from the outer layers into the inner endosperm during the parboiling process. McCarrison[55] has, however, shown that vitamin A which is present in raw paddy or rice

[43] McCarrison, R., *Ind. Jour. Med. Res.*, 1928, **15**, 915.

[44] Srinivasan, C. R., *Rice Production and Trade in the Madras Presidency*, 1934, p. 61.

[45] Ishaq, Abder Rahman, *Dept. of Agric. Bombay, Bull.*, 1920, **99**.

[46] Braddon, W., *The Cause and Prevention of Beriberi*, 1907.

[47] Fletcher, W., *Lancet*, 1907, **1**, 1776.

[48] Fletcher, W., *J. Trop. Med. and Hyg.*, 1909, **12**, 127.

[49] Ellis, W. G., *Brit. Med. Jour.*, 1909, **2**, 935.

[50] Fraser, H., and Stanton, A. T., *Studies from the Inst. for Med. Res.*, 1909, No. 10; 1911, No. 12.

[51] Fraser, H., and Stanton, A. T., *Phil. Jour. Sci.*, 1910, **5**, 55.

[52] Fraser, H., and Stanton, A. T., *Lancet*, 1912, **2**, 1005.

[53] McCarrison, R., and Norris, R. V., *Ind. Med. Res. Memoirs*, 1924, No 2.

[54] Aykroyd, W. R. *Jour. of Hygiene*, 1932, **32**, 184.

[55] McCarrison, R., *Ind. Jour. Med. Res.*, 1923, **11**, 323.

is destroyed in great part during the parboiling of paddy and that pigeons fed exclusively on parboiled rice develop symptoms of ophthalmia. McCarrison and Norris (*loc. cit.*), while confirming the above observation, have further shown that the boiling and steaming of paddy (parboiling) with subsequent sun-drying reduces its nutritive value, and that it is related to loss of vitamins A and B consequent on the action of heat and oxidation. It would appear from the above that the influence of parboiling on the vitamin content of the grains has to be more thoroughly investigated and conditions determined for their maximum conservation. No scientific study on the effect of parboiling on the chemical composition and the nutritive value of rice or on the biochemical changes undergone by the grain during the process of parboiling has also been carried out. It may be mentioned that recent observations in these laboratories have shown that parboiled, milled rice is richer in nitrogen, phosphorus and minerals in general than raw rice milled to the same extent.

At one time, rice of commerce was entirely hand-pounded. The product thus obtained was always slightly coloured and was associated with a small quantity of bran. With the advent of machinery, however, human labour (with its desirable imperfections) was steadily eliminated until to-day we find that not only exported rice but also a very large part of the grain used for home consumption is entirely mill-pounded and polished. The polishing is generally carried to such an extent that the bran layer is almost entirely removed. It is now being increasingly realised, however, that polished rice is devoid of vitamin B_1 and other essential growth promoting factors which are lost with the bran. It would be desirable, therefore, to adopt some system of pre-treating rice which would reduce losses through polishing to a minimum; to combine the pleasing appearance and the keeping quality of polished rice with the superior nutritive value of unpolished rice. It has been found that parboiling under certain standard conditions achieves this end and if this is confirmed by further experiments, such a procedure would deserve to be extensively adopted. Carefully prepared parboiled rice mills better than raw rice and keeps well. On polishing, its colour improves considerably. The finished product cooks nearly as white as raw rice.

The foregoing are but a few instances to show the importance of a systematic investigation on quality in crops. Detailed study of some of the problems mentioned above would not only throw light on the nature of physiological response of plants to a variety of conditions, but also help considerably to modify our present system of agriculture so as to combine quality with quantity. Scientific study of quality in crops is yet a virgin field of research and one from which far-reaching practical results might well be forthcoming. It is pleasing to note that some of the problems referred to in the course of this review are already under investigation at some of the research stations in this country. Particular mention may be made of the researches on quality in tea and coffee at Tocklai, Devarshola, Balehonnur, Bangalore and elsewhere; studies on rice at Dacca, Bombay, Coimbatore, Bangalore and at other stations; enquiries on the nutritive value of various foodstuffs at Coonoor, Bombay, Bangalore and a few other centres. Much more yet remains to be done and it is hoped that, in the years to come, it may be possible to combine high yields with superior quality, thus providing the consumers with cheaper and, at the same time, better acceptable and more wholesome food than in the past.

Quinochromes.

THE oxidation of the non-fluorescent Vitamin B_1 by permanganate and manganese oxides at pH 6-7, is accompanied by the production of a blue fluorescent substance, which is yellow in acids. Sulphur is not split off as sulphate but the state of combination of S changes. This product shows biological activity even though it does not give the formaldehyde-azo colour reaction for Vitamin B_1, which indicates that more than one Vitamin B_1 exists. The properties of the blue substance are discussed in an important paper by Kinnersley and collaborators (*Biochemical Journal*, 1935, **29**, 2369-2384). The authors are led to the conclusion that the view that Vitamin B_1 might be thiophyramidazine (hexahydrothiolumichrome) is no longer tenable. Vitamin B_1 appears to be pyramidine thiazole. It is probable that both the biological activity and the colour reaction are connected with the $-NH_2$ group at 6, which would therefore be capable of existing in two states of oxidation $-NH_2$ and $=NH$.

Permo-Carboniferous Life Provinces, with Special Reference to India.

By B. Sahni, SC.D. (Cantab.)
(*Professor of Botany, University of Lucknow.*)

AT the recent meeting in Amsterdam (Sept. 2–7, 1935) of the Sixth International Botanical Congress, the inter-relations of the Late Palæozoic floras were discussed by various geologists and palæobotanists. After Professor T. G. Halle's Presidential Address to the Palæobotanical Section, Professor A. C. Seward, F.R.S., opened the discussion with remarks on the "Nature and significance of geobotanical provinces". He dealt, *inter alia*, with the difficulties attending a decipherment of the records of the rocks, particularly those connected with the climatic implications of extinct forms of plant life. Perhaps the most striking observation in this masterly discourse, characteristic of a man of Professor Seward's authority and experience, was that today he knew less about the value of fossil plants as tests of climate than he did forty-three years ago, when he wrote his well-known Sedgwick Prize Essay for the year 1892. Among others who followed with papers on various aspects of the problem, was Professor Halle himself, who discussed the relation between the Late Palæozoic floras of Eastern and Northern Asia (pp. 227–228).[1] Professor R. Kräusel of Frankfurt a.M. spoke on the distribution of the Devonian flora. Professor W. Gothan of Berlin dealt in two papers with the inter-relations of the Permo-Carboniferous life provinces (pp. 226; 242–244). Professor W. J. Jongmans of Heerlen discussed the distribution of synchronous floras with special reference to the movement of the poles and of continental blocks (pp. 239–242). Professor A. Renier of Brussels offered remarks on stratigraphical correlations in and between the geobotanical provinces (pp. 244–245). Lastly, the present writer read a paper on the *Glossopteris* flora of India and its phyto-geographical relations (pp. 245–247), of which a summary is given below.

Immediately after the Amsterdam Congress, an international gathering of about eighty geologists and palæontologists met in Heerlen (Sept. 9–12) for the Second Congress of Carboniferous Stratigraphy under the auspices of the Geologisch Bureau of the Nederlands. Here we had the advantage of the presence of the veteran geologist Dr. W. A. J. M. van Waterschoot van der Gracht, Mr. D. N. Wadia of the Indian Geological Survey and other geologists interested in tectonic problems connected with Asia. Among many interesting and important items on the programme, Professors Jongmans and Halle presented their Amsterdam papers again under these new auspices, and in this connection the writer also had the privilege of discussing that part of his paper which dealt with the relations of the Indian Gondwana flora with those of Siberia and China.

As the space allotted for the advance abstracts of the Amsterdam Congress was necessarily limited, and as the full paper will be delayed in publication, I propose to give below an extended summary in the hope that it may be of interest to readers of *Current Science*. The full paper will appear in the *Proceedings of the Indian Academy of Sciences* for 1936.

It is generally agreed that towards the end of the Palæozoic era there existed four more or less well-defined botanical provinces. In the southern hemisphere there was the Gondwana continent, with its very characteristic *Glossopteris* flora. This flora also extended into India, which now lies north of the Equator. Gondwanaland was separated by a great Mediterranean Ocean, the Tethys, from the other three provinces which had more or less distinct floras of their own. These were, *firstly*, the Arcto-Carboniferous province, inhabiting the area now occupied by parts of Europe and eastern North America; *secondly*, the province of the *Gigantopteris* flora, developed in parts of western North America and in China, but extending south into Sumatra; *thirdly*, the Angara province, stretching eastwards from near the Ural Mountains as far as the Pacific Coast, and southwards as far as the Tarbagatai Range, within a few degrees north of Kashmir. The floras of these three northern provinces have more in common with each other than any one of them has with the Gondwana flora. Their geographical relations are best understood by viewing the globe from the Arctic pole (Fig. 1).

[1] These page references are to the *Proc. 6th Internat. Bot. Congr.* (Sec. PB), Amsterdam, 1935, Vol. II.

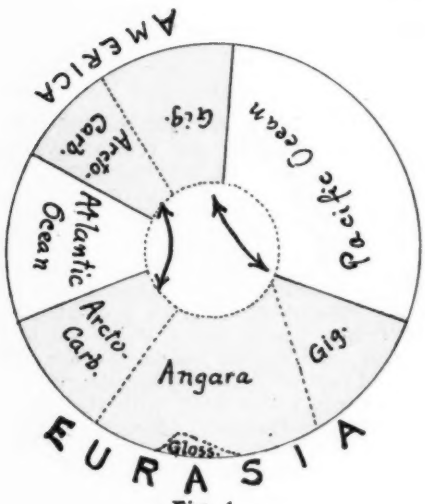

Fig. 1.

It is noteworthy that both the Arcto-Carboniferous province and the *Gigantopteris* province are cleft longitudinally into two blocks each, the blocks of each pair being separated by wide oceans, the Atlantic in the one case, the Pacific in the other. But towards the pole the two halves of each province tend to approach each other, although their actual meeting has not yet been proved. In Eurasia, the Angara flora is wedged in between the other two floras. In its affinities, so far as they are understood at present, the Angara flora is perhaps the most interesting of all, because it contains elements of all the other three floras in addition to a large proportion of genera and species peculiar to itself. The synthetic nature of the Angara flora is perhaps best understood if we look at the globe from, say, the Altai Range: Angara Land is then seen to occupy a central position, as one amongst the four life provinces. Lastly, the *Glossopteris* flora, although containing stray elements of the "northern" type, is for the most part a distinct assemblage, strongly characteristic of the southern hemisphere. This province is perhaps best seen from the southern pole, although from there India goes out of the view.

The present relative positions of these four life provinces raise palæogeographical problems which have led to much speculation. If, as seems probable, these floras were largely contemporaneous, it is difficult to imagine that two floras so distinct from each other as, for example, those of India and Sino-Sumatra should have evolved and flourished side by side, where we now find them on the map: almost cheek by jowl and crossing much the same latitudes. On the other hand, there is the equally puzzling anomaly that countries with closely related floras lie on the opposite sides of the biggest oceans of the globe: China and western North America; eastern North America and Europe; India and the southern continental blocks. But these are only a few of the problems with which the whole subject bristles. The satisfactory solution of all these problems is a thing of the distant future; but that future has been brought somewhat nearer by the recent work in Central and Eastern Asia of Swedish, American and Chinese investigators, and elsewhere by a host of workers on different aspects of the subject.

In the following necessarily condensed account, I shall first record my conclusions regarding the geological range of the Indian *Glossopteris* flora and the climatic conditions in which it was probably evolved, and then pass on to a brief discussion of its relation with the contemporary floras of Siberia and China.

THE *Glossopteris* FLORA OF INDIA AND ITS PHYTOGEOGRAPHICAL RELATIONS.

1. In India the *Glossopteris* flora probably ranged from the Upper Carboniferous to the Trias. The lower limit is indicated by the relations of the Talchir glacial beds and the earliest plant-bearing Gondwanas with marine fossiliferous horizons of determinable age, particularly in Kashmir and in the Salt Range.

Beginning in all probability as a meagre cold temperate flora in the latter part of the Talchir (Upper Carboniferous) period, it rapidly became richer as the climate became warmer (Damuda = Permian). In the Panchet stage (Lower Trias) stray elements of the then widespread *Dicroidium* (*Thinnfeldia*) flora became mingled with a still dominant *Glossopteris* flora. In the Parsora stage the *Dicroidium* element seems to have predominated over a waning *Glossopteris* flora. *Glossopteris* itself has not been recorded from Parsora itself but *Nœggerathiopsis Hislopi* and other characteristic Lower Gondwana plants co-existed with several species of *Dicroidium*, which abounded. The Parsora beds cannot possibly be of Jurassic (Upper

Gondwana) age, as C.S. Fox[2] believes: they clearly belong to the Permo-Triassic part of the Lower Gondwanas and may be even as old as the Upper Permian, as Professor Seward has suggested.[3]

2. The meagre evidence available supports the current idea that the main part of the *Glossopteris* flora was developed in a temperate climate. There is certainly no evidence that it was in any sense a glacial flora, a'though in sheltered spots early members of the flora may well have co-existed with the retreating ice. Nor is there any clear evidence of tropical conditions such as are believed to have existed in the Arcto-Carboniferous province.

3. The only other Carboniferous flora known in India is the geographically important Himalayan outpost of the *Rhacopteris* flora in Spiti (Thabo stage of the Po Series) which, as Gothan has suggested, is probably of Lower Carboniferous age, not Middle Carboniferous as formerly believed.

4. In several parts of Gondwana Land, particularly in South America and South Africa, species related to or identical with members of the European flora have been found associated with the indigenous southern flora. These so-called "northern" elements have generally been regarded as immigrants, but I am inclined to interpret them as remnants or descendants of the pre-existing southern flora. They occur chiefly in the earlier Gondwanas and have been compared or identified with European Upper Carboniferous or Lower Permian forms. Some of the lycopods are comparable with pre-Gondwana southern types. They may have persisted through the glacial period in regions relatively free from the rigours of the ice.[4]

5. The relations of the Indian *Glossopteris* flora with the Palæozoic flora of Angara Land are still very imperfectly known. The Angara flora, of which our modern knowledge is based chiefly upon the works of Professor Zalessky and of Miss Neuburg, contains (i) a large indigenous element, peculiar to Angara Land, (ii) a very considerable Arcto-Carboniferous element, (iii) a small but important *Gigantopteris* element, quite recently discovered, and (iv) a large number of forms more or less resembling, and a few perhaps identical with, plants characteristic of Gondwana Land. Although the Gondwana affinities may have been somewhat over-emphasised in the past, as Halle and others have suggested, there seems no doubt that the two floras were not evolved independently: some means of intermigration must have existed. Whether this was by a direct route, through Kashmir, as suggested by the writer in 1926, or by an indirect route, possibly through China, is an open question. Meanwhile, a critical comparison of typical specimens of the two floras is urgently needed; a comparison of the faunas should also be helpful. The Lower Gondwana flora of northern India, particularly that of Kashmir and the Salt Range, should be further explored; and any acquisitions of plant-fossils from the ancient coast-line of Gondwana Land, which lay along the southern margin of what is now the Himalayan chain and on the east from Assam to Burma, should be closely examined. Investigations in the intervening region between northern India and the Altai range may possibly bridge the already narrow gap between Kashmir and the southernmost Angara localities in the Tarbagatai. In that case, as tentatively suggested in 1926 (*loc. cit.*, p. 241) the Kashmir flora may be only a southern outpost of the Angara flora.

But, on the other hand, it may after all turn out that the suggested affinity of the still meagrely known Kashmir flora with that of Angara Land was only apparent, or less close than imagined. Certain geological considerations would seem, indeed, to preclude any means of terrestrial migration from Kashmir to Siberia during the late Palæozoic. D. N. Wadia's important work in N.-W. Kashmir and Hazara[5] seems to have established that the chain of the Himalayas, representing the uplifted and folded marine sediments of the Tethys, is structurally continuous round the great re-entrant angle in our northern mountain barrier. Unless further investigations reveal evidence of a break in the marine zone, either here or further to the west or east, the marine barrier between India and Siberia must have been a truly formidable one: it is now represented, as Dr. van der Gracht

[2] Fox, C. S., "The Gondwana System and related formations," *Mem. Geol. Surv. Ind.*, 1931, **58**, 189-190.

[3] Seward, A. C., "Fossil Plants from the Parsora Stage, Rewah," *Rec. Geol. Surv. Ind.*, 1932, **66**, (ii), 242.

[4] Sahni, B., "The Southern fossil floras, a study in the plant-geography of the past," *Proc. 13th Ind. Sci. Congr.*, Pres. Addr. to Geol. Sec., Bombay Meeting, Jan. 1926, p. 241.

[5] Wadia, D. N., "The syntaxis of the N.-W. Himalayas", *Rec. Geol. Surv. Ind.*, 1931, **65**, (ii), 189-220.

emphasised at Heerlen, by some of the highest mountain ranges in the world, including the Himalayas and the Karakorum. In the face of these considerations, Zalessky's hypothesis of a connecting isthmus or a chain of islands across the Tethys does seem bold, but then the Gondwana resemblances of the Angara flora, which, I believe, are undeniable though they may have been exaggerated, must be explained by an indirect route, still to be discovered. This is a point on which investigations not only in China and Central Asia but also along the old Gondwana coast-line in the Nepal-Assam-Burma region may be expected to throw light.

6. Further east across the Tethys, in China, there flourished a vegetation which had much more affinity with that of the Euramerican continent, and some affinity even with that of Angara Land. With the Gondwana flora there was much less in common. But although essentially a northern flora, the *Gigantopteris* flora crossed the equator into Central Sumatra[6] where it appears to have pushed itself like a wedge into the Gondwana province. I believe that this peculiar dovetailing of the sharply contrasted northern and southern floras can only be explained on the view that originally the two provinces were far separated by the ocean (Fig. 2), but have since been brought into contact by a horizontal drift of one or (as I consider much more probable) both land areas (Fig. 3). The old Gondwana promontory of N.-E. Assam may be regarded as a pivot round which the Burmo-Chinese mass, formerly situated much further to the north, moved southwards and westwards, along the arc of a circle.

How far this suggested syntaxial bend round N.-E. Assam, compared with that which Mr. Wadia has so ably demonstrated in the N.-W. Himalayas, is supported by structural geological evidence, is for the future to show. The idea was suggested to me by purely palæobotanical considerations but, as I learned subsequently, several geologists have previously expressed the belief that the chain of the Himalayas is continued southwards round Assam into Burma and the Malayan arc of islands. The alternative view of Kingdon Ward that the Himalayas continue eastwards through China, as far as the Pacific Coast, seems quite untenable, as the region of China where his supposed eastward continuation would lie was a land area inhabited by the *Gigantopteris* flora.

It may be that the present region of Sumatra formed a *southward* promontory of the northern continent, round which the sediments of the intervening geosyncline, lying to the north of the Indo-Australian mass, became folded and bent into an angle or arc, in much the same way as round the Kashmir and Assam promontories. But the position in this region seems much more complicated, and in any case the subject is beyond our present scope. The main point one may venture to suggest is that palæobotanical explorations in the Malayan arc and further to the east should probably establish the eastward or north-eastward continuation of the tectonic boundary between Gondwana Land and the *Gigantopteris* province.

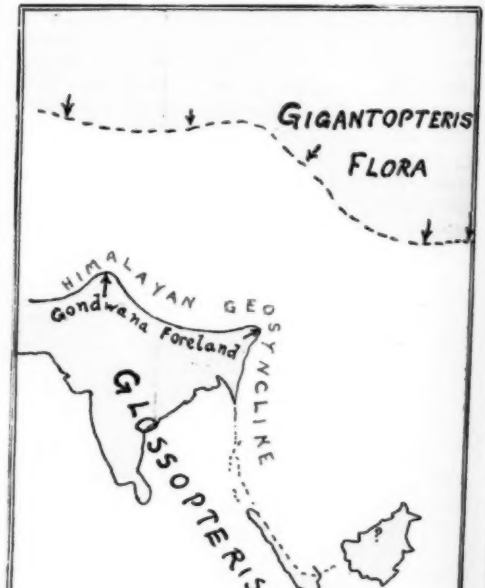

Fig. 2.

[6] Jongmans and Gothan, "Beitr. z. K. d. Flora des Obercarbons von Sumatra," *Med. Geol. Bur. Nederl. Mijngebied*, 1925, No 2; Posthumus, O., "Palæozoic flora of Djambi," *Proc. Kon. Acad. Wet., Amsterdam*, 1927, **30**, (6); Jongmans and Gothan, (1935) "Die palæobotanische Ergebnisse d. Djambi-Expedition," *Jaarb. Mijnw. in Nederl-Ind.*, 1930, "Verhandelingen".

Fig. 3.

It remains to add that while the above ideas were arrived at independently I owe the original impetus for them to certain suggestive remarks made by Professor Halle, in his classical memoir on the Shansi flora,[7] where he drew attention to the close proximity of the Indian and Chinese floras and hinted that this anomalous position may have had something to do with the tectonic features of the intervening region. The above hypothesis would also explain the apparent anomaly of two climatically distinct floras lying, as they now do, athwart the same latitudes. There need not, therefore, be any serious difficulty, at least on geographical grounds, in accepting the idea that while the "Arcto-Carboniferous" flora (including its Sino-Sumatran phase) was developed in a relatively warm and humid climate, the *Glossopteris* flora was essentially a temperate flora.

In reply to an enquiry my esteemed friend Mr. Wadia also wrote to me that he thought a N.-E. tongue of the Indian horst had much to do with the acute southward bend of the Assam mountains into Burma. To him and to Dr. F. R. Cowper Reed, I am indebted for references to geological literature on this aspect, which showed that the problem has already received attention from many geologists. To mention only the most recent instance, I learned that the idea of Assam as a resistant pivot, round which the far eastern block probably drifted southwestwards into its present position, has also been recently expressed on geological grounds by M. Fromaget,[8] Director of the Geological Survey of Indo-China. Lastly, it was gratifying to find that at the Amsterdam Congress Professor Jongmans expressed ideas essentially similar to those presented in my paper, read the same day.

[7] Halle, T. G., "Palæozoic plants from Central Shansi," *Palæontologia Sinica*, 1927, Ser. A. **2**, (i), 288-290.

[8] Fromaget, J., *Essai sur l'évolution paléogéographique de l' Indochine, etc.*, Hanoi, 1934.

With so much concurrence on the essential points, I think that we may feel satisfied about the stability of our main conclusions. About ten years ago, in an essay on a broad survey of the "Southern Fossil Floras",[9] I said that it was the scattered distribution of the previously glaciated areas of Gondwana Land that provided the main support to Wegener's hypothesis: palæobotany did not seem to me at the time to lend any clear evidence in favour of it. The Carboniferous glaciation of the southern hemisphere still appears to me to be the main pillar on which Wegener's idea rests. But I now feel that palæobotanical considerations, such as those set forth above add another, though modest, support to this remarkable theoretical edifice, at least so far as concerns the movement of continental masses through wide ranges of latitude and longitude.

[9] Sahni, B., *loc. cit.*, 1926, 233.

Antiquity of Lac and Superstitions Connected with It.

By M. Sreenivasaya.

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THE Indian Lac Industry enjoys a venerable antiquity dating as it does to the times of the Puranas. Reference to lac is made in "Mahabharata" in connection with the "*Laksha Griha*" or palace of lac, which was built to ensure and burn down the Pandavas. Kautilya mentions the product in his celebrated "Arthasastra". Coming down to very recent times Abu-l-Fazl who was in the Court of Akbar, refers to lac as being employed for varnish making.

In Ayurveda, lac is extensively employed, both for external application and internal administration. Shellac, finely powdered and mixed with honey, is given as a specific for hæmostosis. It forms one of the main ingredients of a medicated oil known as *Lakshadi Thaila* which is reputed to bring down chronic fevers, cure rheumatic pains and help the growth of fœtus during pregnancy. Decoctions of lac are administered to consumptive patients with good effect. Germicidal, febrifuge and astringent properties are attributed to lac. It is not clear to which constituent of lac the medicinal property is attributable. When decoctions are made, the body fluids of the insect which go into solution are involved but when the medicated oil is prepared, the wax and the insect fat dissolving in the oil, constitute the effective ingredients. It is not clear whether brood lac consisting of all the living insect mothers or the "*phunki*" lac containing only the dead insect bodies, is used. Local information points to the conclusion that the most effective and potent preparations are those made from brood lac which is not always available to the Ayurvedic Pundit. It is quite conceivable that the medicinal value of the wild lac is higher than that of the commercial species.

This ancient industry is naturally connected with a number of "superstitions" some of which appear to have a sound scientific foundation. Those who generally cultivate lac form a caste by themselves in Mysore, and they observe these superstitions in a most religious manner. The uncertainty which characterises lac crops is signified by the saying that "the ferry boat, lac and Tasar depend on God". These three things cannot be controlled by human beings. It is believed that all lac-bearing plants are haunted by evil spirits which are responsible for all kinds of damages and crop failures. To propitiate these evil spirits and invoke their good favour, rams, goats and chickens are offered to them in sacrifice.

The solar or the lunar eclipse, especially when it synchronises with either the swarming of larvæ or the emergence of males, is believed to be fundamentally calamitous to lac crops. On such occasions it is not unusual to find liberal animal sacrifices being offered in the field.

Host plants need a change of physiological condition before they can bear bumper crops of lac and the desired change can be brought about by repeated lac infections and successive prunings for several consecutive years. This is an observation of great value and is fully borne out in modern field practice; but an adequate scientific explanation of this observed fact cannot at present be given. The successive infections and prunings will result in altering the ratio of top to root to the optimum point.

Brood lac should not be harvested until the larvæ are seen to swarm out of their mother-cells in pretty good numbers and

settle on the tender positions of the shoot at least to the extent of about 4 inches. There is much to be said in favour of this recommendation although the latter half may have to be modified to a certain extent.

The insects resulting from prematurely cut brood lac generally lack in vigour and do not build up healthy encrustations. This is an observation with which all practical lac growers will entirely agree.

Those of the insects which swarm out in the first stage are the best since they are found to build up the thickest encrustations and maintain a vigorous state of health. Those which swarm out subsequently are weak and suffer from heavy mortality for one reason or other.

Lac does not grow at the tip of the branches.

Brood lac should be used for infecting soon after they are collected. If it be desired to keep them longer for a day or two, they should be stored up in a cool place buried under paddy husk, which prevents the profuse and rapid swarming of larvæ. This highly suggestive observation can be extended to an alteration of swarming periods within wide limits, with the ultimate idea of controlling the rate of swarming in accordance with climatic factors which may be prevalent during the period. This problem of artificially controlling the rate of larval swarming has an important practical bearing which will be referred to later.

Swarming of insects commence with the rising of the sun and cease with the setting.

Lac insects are very sensitive. On cloudy days or in chilly weather, they do not swarm out of their mother-cells. In the course of swarming, if it suddenly commences to rain, with a consequent fall in temperature, the insects are said to go back to their mother-cells, which is a fantastic idea. Under heavy showers the larvæ get washed out and have not been observed to return to their mother-cells.

Insects swarming out of the mother-cells, come down straight to the ground and then crawl up the trunk and branches and strive to find suitable places. It is believed that without first touching the ground, by way of propitiating mother earth who gave them life, the young larvæ do not commence their careers.

The man who infects lac is expected to observe certain religious rites until the "*phunki*" lac is removed from the host plants. He is prohibited from having a shave, nor can he take an oil bath. It is believed that a violation of these injunctions will lead to the branches appearing clean shaven and besmeared with oil, deprived of all encrustations which would be built up if the operator religiously observes ceremonial usages.

On the day, when "*phunki*" lac is collected from the host plant, milk is boiled underneath the host plants in a new earthenware pot. The vigour with which milk boils and foams over is taken to be an indication of the future abundance of the white filaments characteristic of healthy and bumper crops.

Hail storms and fogs do not favour the growth of lac.

If it rains in the month of January palas lac may die while April rains are fatal to kusum lac. These represent two particular rains known as salt rains which are not favourable to lac propagation.

A single cell of kusum-brood lac is equivalent to a stick of palas-brood lac.

This is supposed to give us an idea of the relative number of insects in the two different varieties of brood lac.

Lac is supposed to grow very well on the lower branches during the rainy season and on the top branches during the winter.

Most of the observations which have been detailed above, have a scientific bearing and are doubtless the result of keen observation while some of them appear to be highly fantastic.

Lt.-Col. A. D. Stewart, C.I.E., I.M.S.

IT is unfortunate for India that those who serve her in an official capacity must retire at about an active middle age. New recruits are constantly joining to fill up the ranks but just as constantly do the senior and experienced ones resign when they are so capable of carrying on for many further years. In September 1935 Lt.-Col. A. D. Stewart gave up his appointment as Director of the All-India Institute of Hygiene and Public Health and Professor of Hygiene in the School of Tropical Medicine, Calcutta, in order to take up the post of Superintendent of Edinburgh Royal Infirmary.

Col. Stewart is, as we all know, a native of Scotland. He was born in 1883 and after terminating his school days in Dux he entered Edinburgh University as a Medical student in 1901. He graduated in 1906 and entered the I.M.S. in the same year. From 1907 to 1931 he was in military employment, and just before the War was Medical Officer of Health, Simla. During the Great War he saw much active service, serving in Egypt and the Suez Canal area, at Gallipoli and the landing at Cape Helles, in the Senussi expedition in Western Egypt, in Mesopotamia and as surgical specialist on the hospital ship *Vasna*, and finally as D.D.M.S., Bombay. He was mentioned in the final war despatch by the Government of India.

On reverting to civil employment after the War, Lt.-Col. Stewart served from 1919 as Medical Officer of Health, New Delhi,—a post which called for special qualifications as the laying-out of the Imperial Capital involved many serious problems of public health.

In 1921 he came to Bengal and served in turns as Director of the Bengal Public Health Laboratories, Director of Public Health, Bengal, and Professor of Hygiene at the Calcutta School of Tropical Medicine. In 1926–1928 he was appointed Principal of the Calcutta Medical College, and had a very strenuous time in reorganising that institution and putting it on a sound basis.

In 1929 the scheme for an All-India Institute of Hygiene and Public Health matured, and the construction of the building and its equipment were undertaken by the Rockefeller Foundation at a capital cost of Rs. 16 lakhs. Lt.-Col. Stewart was selected as Director Designate of the Institute in 1929, and in 1932 became its first Director.

Col. Stewart's knowledge of public health conditions in India and, Bengal in particular, was both wide and practical. His main experience in the field was gained as Director of the Public Health Laboratories. Consequently when the Rockefeller Foundation proposed the Institute in Calcutta, they clearly saw that Col. Stewart was the man to whom the design and the Directorship should be given. While holding this post Col. Stewart was in an ideal position for utilising his knowledge and experience. There was hardly a problem or inquiry into public health conditions of Bengal in which he was not consulted. He was Chairman of the Conference of Cholera research workers in India where his capacity for appreciating not only the main issues of field work but also the finer details of antigenic structure, were of inestimable value in guiding the diverse activities of the members as a whole. He was also a member of the Malarial Advisory Committee of the Bengal Sanitary Board where again his intimate knowledge made his opinion of great weight. One of his last meetings was on an inquiry into the Calcutta Water Supply, the administration and technical working of which he probably knew more about than any other member. In 1933 he was appointed by the Government of India—as their representative at the Office International d'Hygieno Publique at Paris where his views on such international problems as cholera were carefully listened to.

OTHER ACTIVITIES.

His valuable work for the two medical institutions in Calcutta, however, does not complete the story of Lt.-Col. Stewart's manifold activities in Bengal. For twelve years he has been an active and zealous Fellow of the Calcutta University, and that institution owes much to him for his help and advice with regard to its public health diplomas. He has also served for many years on the State Medical Faculty of Bengal, the Bengal Council of Medical Registration, and in connexion with the inspection and regulation of medical schools and colleges throughout the Province.

He has for many years been prominent in connexion with the work of the St. John's Ambulance Brigade in Calcutta, and was for

two years Assistant Commissioner of the Calcutta District.

Members of the Staffs of the All-India Institute of Hygiene and Calcutta School of Tropical Medicine will lose, with Lt.-Col Stewart's retirement, the services of a most loyal and devoted colleague, and a teacher of wide experience and specialised knowledge.

In addition to Lt.-Col. Stewart's own work, mention must be made of the services of Mrs. Stewart on many social and public health committees in Calcutta, and especially in connexion with the annual Calcutta Health Week.

Lt.-Col. Stewart has published many papers on public health and medical research subjects in the *Indian Medical Gazette* and the *Indian Journal of Medical Research*. He was the author of manuals on tropical hygiene and public health laboratory practice. Many of these were devoted to the question of sewage inactivation and water purification, a result of which was a valuable suggestion for the improvement and economy in the use of alum. He also published a considerable amount of extremely important work on the bacteriology of food, sewage and water while in charge of the public health laboratories. His work in Bengal during the last 15 years has contributed very materially to raising the standard of public health in the Province and towards the solution of Bengal's many and difficult problems in health welfare. He received the C.I.E. in 1934 in recognition of his valuable services to India.

Col. Stewart was a man of interests extending far beyond his work. He was keenly interested in music and while serving with a Gurkha Regiment in his early days he wrote down and collected a number of their folk melodies. He neglected no opportunities for taking up other hobbies as the above illustration shows and Geology was similarly studied not from books but from direct observation in the field. Among the numerous other activities in which he joined and encouraged was the Bratachari movement in Bengal which aims at the revival of folk music and dancing. He was widely read and never failed to be an interesting conversationalist both light and serious. During his last few years in India in spite of the many demands made on him he illustrated in no small degree the rule that the busiest man has always time to spare. No one left his room without getting his full attention, courtesy and help. He had a shrewd judgment and always grasped the main issue whether of a scientific or administrative problem. His criticism was always followed by other constructive suggestions a rare asset, which no doubt contributed largely to the continual stream of work with which he had to deal.

Both Col. and Mrs. Stewart were liked by all with whom they came in contact—no mean accomplishment—and there can be no doubt that Edinburgh has chosen wisely in recalling one of her graduates, who, we all hope, will have many more years of happiness and service in his new appointment.

H. ELLIS C. WILSON.

Craters in the Moon.

DR. F. E. WRIGHT of the Geophysical Laboratory, Carnegie Institute of Washington, recently announced before the National Academy of Sciences, his observations on the relation between the number and size of the craters on the moon. Craters with diameter of 4—8 miles are grouped in one family; those with 9—13 miles, in another and so on. The graph showing the relation between size and number is a smooth curve which is interpreted to mean that the "craters are the expression of a single mode of formation, such as volcanic, or meteoric impact or some other type". "The craters are remarkably circular in outline. The small craters have the aspect of simple depressions with walls which rise only slightly above the level of the surrounding country. They are more of the nature of pits or holes in the ground, not unlike the crater holes produced by the impact of an explosive bomb. As the size of the crater increases, the crater floor is less even and usually contains subsidiary craters and elevations."

Letters to the Editor.

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The Mathematical Theory of a New Relativity.

IN the September number of *Current Science*[1] some criticisms by "B. S. M." of my Theory have been published. I heartily welcome such criticisms because they give me an opportunity to elucidate the points which may not be clear. I am briefly replying to the criticisms in the various paragraphs seriatim, reserving a more detailed examination for a later occasion.

§ 1.

1. I have never claimed that my Theory deserves Harlow Shapley's characterisation of it "as one of the high lights of astronomy," and I myself was surprised at the generosity of his remarks. It is a mere presentation of a new Theory still in its infancy which, applying Newtonian principles, with necessary corrections, claims to deduce the formulæ which are the pride of Relativity. It is not for me to say anything as regards the insinuation that Shapley's reference was not based on a critical study of the article.

2. D. R. Hamilton's criticism that my explanation of the advance of perihelion would lead to "absurdly erroneous" results has been met by me in Chapter VI of my paper.[2]

3. "On the mathematical side not much notice has been taken."—The critic refers to the mention of my article by the Zentralblatt fur Math., and omits to refer to the *American Mathematical Monthly*.[3] He has not also referred to *Nature*.[4]

§ 2.

4. His objection to the choice of the name "A New Relativity," needs no notice. I am certainly "vehemently opposed" to the extraordinary assumptions of Einstein's Relativity, but in no way to a "principle of Relativity in any form whatsoever". I maintain that Einstein's postulates are only approximately and not exactly true.

5. I gladly welcome the admission that "Relativity is not the only example of a physical theory which appears absurd when its logical consequences are pushed to their very limit." The very fact that the Principle of Relativity (special as well as general) has been unable to make any substantial progress from any other hand except that of its creator, and even not much from him since 1916, shows that it is not the last word on the problems which it claims to solve.

6. The quotation from Jeans' *Mysterious Universe* at page 228 is not objected to, and the page of the book also was correctly given. But the critic has pounced upon a misprint and expressed his curiosity at finding this mistake in the list of references at the end. Unfortunately there were no less than 13 misprints in the first paper already pointed out in the *Errata*, and there are more misprints in the second paper other than the two mentioned by the critic, which have been corrected in the second *Errata*.

7. "There are some misstatements of fact in the author's references to Relativity the most serious of which are in connection with the observational verifications of the general theory of Relativity."—I shall deal with the subject at considerable length in Chapters X, XI and XII of my next paper, which will show that the claim of Einstein's General Relativity that it has been verified is unfounded.

8. He considers that Chazy's observational value for the advance in the longitude of perihelion of Mercury is "the best observational data".—I suppose it is a great pity that although Chazy's value was published in 1926,[5] it was overlooked by Eddington in his later works. The critic is obviously unaware of the more recent literature to be discussed in Chapter X, which will also show the great uncertainty due to certain assumptions in the calculation of the advance of the perihelion. So much so that von Gleich has actually asserted that the supposed excess of motion of the perihelion of Mercury does not exist and the Newtonian theory of gravitation needs no correction by Relativity.[6]

9. He considers that "the most satisfactory data (on the deflection of light) available at present" are those of Campbel and Trumpler.—This is relying on a rather stale literature of 1923 in ignorance of the bad exposure made by Freundlich (quoted in Chapter II, p. 25) that if necessary corrections are introduced, the three cameras of the American Expeditions of 1922 give the values 2″·20, 2″·30 and 2″·10 respectively.[7] Freundlich has discussed in detail all the previous works including those of Campbel and Trumpler and shown that the value obtained by the latter was due to an inaccuracy in balancing the observations and that their value of the deflection also is 2″·27. It will perhaps shock the critic to learn that Lanczos, a great worker on Einstein's Relativity, has also pointed out that with the necessary corrections Campbel and Trumpler's value comes to 2″·20.[8] Of the three tests, the deflection of light is the only one that is reliable, and in this Relativity has already failed.

10. (i) The later observations of St. John[9] as regards the shift of spectral lines of the Sun are supposed to be "quite satisfactory".

It will be shown in Chapter XII that the agreements are found only for different arbitrarily chosen levels for the centre and the edge, there being marked positive and negative residuals for higher and lower levels. The discrepancies range between ± 25 per cent. which can hardly be called "quite satisfactory". The discrepancy at the edge is conveniently explained by some unknown "edge effect". The discrepancy is greater when the average of $M\Sigma\left(\frac{ad\lambda}{\lambda}\right)$ is taken, which alone is the correct method. It is well known to every worker on solar physics that wave-lengths on the Sun may differ from those measured on territorial sources on account of a large number of causes.

11. As to the companion of Sirius the assumption of the "quite satisfactory" result is based on Adam's observation.[10] But Vyssotshiy[11] has shown that the density of the companion of Sirius is much less than what has been assumed so far and therefore the radius much larger. If Einstein's value is correct, then so is mine!

The following are stated to be "misstatements of a minor nature":—

12. (1) "Relativistic invariance holds in vacuum only".—Schwarschild's particular solution is of $G\mu_\nu = 0$. As to this Eddington says, "This is the state of the world in an empty region—not containing matter, light or electromagnetic fields, but in the neighbourhood of these forms of energy."[12]

13. "Einstein arbitrarily assumes $C + v = c$ and $c - v = c$."—In relativity the velocity of light is absolute and relative to every frame of reference is the same. Even if two systems S and S′ be moving with relative velocity v, "the resultant velocity relative to S′ is c, the velocity relative to S is also c, whatever the direction".[13]

14. "Milne's theory ignores gravitation and evades collisions."—Compare "The new theory shows that the expansion is in reality a natural phenomenon taking place in the absence of gravitation and proceeding in

spite of it" (p. 2) and "consider a swarm of particles moving in straight lines, each with a uniform velocity without *collisions or other interactions* possessing an entirely arbitrary velocity-distribution" (pp. 6–7).[14]

15. "In Relativity time is wholly imaginary and space illusory."—The unit of time is really $\sqrt{-1}$, and space has four dimensions. What more imaginary and illusive character is wanted than the confusion of space and time?

16. (1) The mathematical part of the work is "quite elementary and does not go beyond the solution of an ordinary differential equation of the second order".—No reference to any book or paper is supplied where even an approximate solution of my equation (5·9) was given before, much less the exact solution. The so-called elementary solution is by successive approximations covering two pages and a half.

17. "Looking from an æsthetic–mathematical point of view one searches here in vain for such concepts like (as) groups, tensors and generalised spaces characteristic of Relativity or functional equations, sets of points, and Finsler spaces relevant to Milne's new Relativity."—The author thinks that paper which does not use Tensors, Groups and other branches of higher mathematics is not a valuable paper at all. Such a suggestion will condemn workers like Maxwell, Bohr, Sommerfeld and many other illustrious investigators, both dead and living. In fact the claim of the New Relativity is that its formulæ are deduced on simple dynamical principles without recourse to such methods. It is not easy to appreciate what objection there can be to its simplicity.

18. Some differential equations are considered to be "not relevant".—Apparently the critic thinks that the complete theory is contained in the five Chapters already published. More have come out since.

19. (iv) The superiority of method over those of Forsyth, Morley and Pierpoint is said to have been "achieved at the cost of a little wrong mathematics". It is conceded that the solution (9·5) is "correctly obtained" but it is asserted that the next solution has been obtained wrongly. The critic says, "It is, however, absurd to use this theorem here since it cannot apply to non-linear differential equations, and moreover is not a particular integral."—It was pointed on pages 10 and 11 that for Mercury $\frac{\mu}{h^2} = 1\cdot73 + 10^{-13}$ and u also is nearly the same, and that k was of the order 10^{-4}. Also θ varies from 0 to 2π. It was accordingly considered too obvious to mention that the second power of $\frac{\mu}{h^2}(1-2k\theta)$ as well as the product $\frac{\mu}{h^2}(1-2k\theta)$. u were negligible. If this obvious fact were borne in mind, it will be found that the general solution given by me is perfectly valid. The correctness of the solution can be easily verified by direct substitution in the differential equation. It is some consolation that the solution in elliptic functions is not called "quite elementary". The critic has not noticed the misprint $\frac{D^4}{\mu^3}$ for $\frac{D^6}{\mu^3}$.

The following observations are regarded as contrary to scientific investigations:—

20. "Nature's limits are not fixed by our capacity to observe them."—Does Nature exist only when seen by man?

21. "Relative velocity cannot mean relative velocity as actually observed, and we cannot go by measurements only."—This is a rather bad paraphrase of my remark "if relative velocity only means relative velocity as actually observed and we go exclusively by measurements only, then the relative velocity between two bodies would depend on the particular method of measurement which is chosen". This remark was in anticipation of Chapter VII, which will throw fuller light on the point.

22. "A certain concept in Relativity is unacceptable because the concept is philosophically an impossible one."—The concept referred to is, in physical language, that there exists a mysterious cosmic force of repulsion, which not only acts at a distance, but increases in intensity as the distance between the two bodies increases.

I am not the first critic to find fault with his conception. Even Einstein has been aware of the weakness of his argument and has been trying to change the assumption. In fact in a paper published in the *Proc. Nat. Acad. of Sciences* jointly by Einstein and de Sitter, λ was taken to be zero. In Cosmos, de Sitter concluded that the theory of the expanding Universe is less definite than it used to be and that we do not even know whether the curvature is positive, zero or negative, whether the universe is finite or infinite.

23. A whole paragraph is devoted to commenting on a reference to Jordan's paper in a short note at the end. It has been repeatedly emphasised over and over again in my papers that the existence of gravitons is not necessary for the Mathematical Theory.

§ 3. GENERAL RELATIVITY.

(*a*) *Advance of Perihelion.*

24. The critic says that there is "no novelty of ideas" as they go back to the work of Laplace, whose theory produced secular perturbations or, in the alternative, a high velocity of gravitation.—Obviously the critic, who has quoted profusely from the *Encyclopædia*, is not aware that Lorentz and Eddington have shown that even on Laplace's own theory perturbations could vanish to the first order terms (see Chapter VII). It has also not been mentioned by the critic that Laplace's theory was based on the idea of pressure caused by a liquid ether owing to which the velocity of propagation was directed from the attracted body towards the attracting body, whereas in my theory, the gravitational influence is propagated equally in all directions outward from the influencing body towards the influenced body, the change of sign making all the difference.

25. It is irrelevant to refer to other theories including Anding's which assumed a new law of gravitation quite *arbitrarily*, and yet did not succeed in getting any satisfactory results. It is one thing to assume arbitrarily a new law of gravitation, and it is quite another thing to deduce a new law from a single assumption of the finiteness of the velocity of propagation. I may mention that if one were to assume a new law of gravitation, I would take it to be $-\frac{\mu}{r^2}-\frac{3\mu h^2}{D^2}\cdot\frac{1}{r^4}$ which will give all the results we want and avoid all difficulties (see Chapter VII).

26. "Remembering that Sulaiman's correction factor does not depend on r, the criticisms levelled against Gerber's theory therefore apply to Sulaiman's theory equally well."—Gerber's theory (referred to by me in Chapter I, p. 4) involved the propagation of potential with finite velocity which Seeliger, Laue and Oppenheim rejected as being impossible. Gerber had also misapplied the Lagrangian equation as pointed out by Pauli. Neither of these defects can be found in my theory. Also my factor is a function of dr/dt which is a function of r, and is therefore not derivable from Gerber's potential.

27. Following in the footsteps of D. R. Hamilton the critic has emphasised at several places that my theory would lead to unforeseen perturbations, and either Mercury would go off in three centuries or the velocity of gravitation should be thousands of times more than that of light.—My replies to Hamilton's criticisms are to be found in Chapter VI, which may be referred to. As Laplace's theory led to a retardation, he was unable to explain the perturbation. My theory leads to an acceleration of motion, which can be adequately explained by the resistance of the medium through which planets pass, as is now becoming clearer from the explanations of Zodiacal light and Gegenschein phenomena. This material difference saves my theory from foundering on the rock on which Laplace's theory did.

28. It is wholly unnecessary for me to discuss the other theories relating to the advance of Mercury's perihelion. The principal defect in Einstein's theory is the unconvincing nature of its fundamental assumption of the absoluteness of the velocity of light.

(*b*) *Gravitational Deflection of Light.*

29. "Gerber's equation does not yield the value for the deflection which is certainly true, and the same should also be true of Sulaiman's equations if properly handled."—The critic has undertaken to rehandle in two ways my equations which, as shown in Chapter VII, was obtained for heavenly bodies where v^2/D is small.

30. (i) He does "the straightforward thing....to write the equations of motion *ab initio* using the relation $v = D$" and curiously gets $\frac{d^2u}{d\theta^2}+u=0$. He has apparently forgotten that, as noted on p. 8, v is the velocity along $S'P=\frac{dr}{dt}\cos\alpha-\frac{rd\theta}{dt}\sin\alpha$ and not along the tangent.

31. (ii) He has verified his result "qualitatively" by putting $v = D$ in $-\frac{\mu}{r^2}\left(1-\frac{v}{D}\right)^3$. [The critic has been freely using such expressions as "absurdly erroneous", "completely false impression", "most serious misstatement", "quite elementary", "drab", "absurd to use this", "results completely against all observed values", "arbitrary", "truly amazing".] But I would refrain from using any epithet for the

critic's mathematics according to which for a light particle no matter howsoever much inclined it may be to the radius vector the form always is $-\frac{\mu}{r^2}\left(1-\frac{c}{D}\right)^2$. This is the supposed "consonance with Gerber's equation"!

32. "When the (author) states that $r\frac{d\theta}{dt}$ can never exceed the *tangential velocity c*, he assumes unconsciously that the tangential velocity is constant, but this certainly cannot be true."—There has never been any such assumption which would be contrary to my theory. I said on page 29, "it disproves the assumption in Relativity that the velocity of light in a gravitational field remains constant". But undoubtedly the change in the velocity c is extremely small.

33. "The assumption of a constant tangential velocity is equivalent to taking the central orbit as circular, and it becomes meaningless to talk of the deflection as the angle between the asymptotes of the orbit."—With the disappearance of the constancy of the velocity, the "meaninglessness" vanishes and so does the circular orbit.

34. The "third mistake" is said to be that "by showing that the least value of the expression is....the conclusion is drawn that the deflection is exactly 4/3 times the Einstein value".—It is not clear where the word "exactly" has been got from. He has apparently misread the word "nearly". On the equation, that was the minimum value only, and the critic has himself quoted my words "at least".

35. "One would naturally inquire what would be the maximum deflection possible, but the work is silent on this point."—It is shown in Chapter VII, section 5, that on that equation the maximum deflection would be 3/2 times Einstein's value. But it will be shown in Chapter XI that in the case of light the equation is only approximately true and not exactly so, thus giving a smaller value for the deflection.

(*c*) *The Shift of Spectral Lines.*

36. "No remarks appear to be necessary in this case, for according to the author's own showing the corrections provided by the New Relativity are not appreciably large and the value of the ratio is the same as Einstein's."—Apparently the critic considers that there is no credit whatsoever in obtaining on purely Newtonian principles the same value for the spectral shift, as is obtained in Relativity with the help of extraordinary assumptions and cumbersome mathematical apparatus, and by treating an electron at the Sun as being "momentarily at rest", a self-contradictory assumption.

37. The value of the shift was the same as Einstein's for light from the centre of the disc.—In the Appendix to Chapter II it is shown that as regards the shift from the limb, there is an appreciable difference in the two values. In Chapter XII (see No. 10 above) St. John's average values will be examined.

38. "No one would seriously think of adopting it as an alternative to the General Theory of Relativity for the explanation of gravitational phenomena."—I can never expect that my theory will be accepted until more accurate future observations are forthcoming to disprove Relativity still more thoroughly.

§ 4. SPECIAL RELATIVITY.

(*a*) *Relative Velocity.*

39. (1) As the Theory is a new one, it is not at all surprising that critics should feel some difficulty in the early stages of its development. In Chapter VII it has been explained that relative velocity must vary with the method of observation. The whole object of obtaining the formula for the compounding of velocities was to show that *if a messenger's double journey method be adopted*, a formula can be obtained which as an approximation would reduce to a form similar to Einstein's. Einstein has assumed his formula to be rigorously true, from which unconvincing results follow in the extreme case. If his formula were taken to be approximately true only so long as the velocities of the bodies are small compared to that of the messenger, I would have no quarrel with it. Indeed, all the results of Relativity can be incorporated in the new Theory within the limits of such an approximation.

40. "Where u and v' are velocities relative to an observer who is at rest in his own system."—In absolute space, "rest in his own system" is not the same thing as absolute rest. *If the messenger's double journey method be employed*, the relative velocity as measured must necessarily be slightly different from Newton's relative velocity.

41. "As an example of confused thinking it is hard to find anywhere in relativistic literature a parallel to the author's derivation of the equation."—Failing to grasp the essence of the theory, the critic has become

angry and uses strong language. Of course, what is not grasped must necessarily appear to be confusing.

42. "An absolute distance between two moving points is assumed as r independent of all measurement."—For Newton's absolute space and time, such an assumption is perfectly sound. My point of view is Newtonian, and the statement is in strict logical agreement with the whole trend of such thought.

43. (1) The critic "deduces an absurd consequence" by putting $v' = D = c$.—Apparently he seriously thinks that *for a double journey method* also $v' = c$, as if a messenger travelling with velocity c can overtake another body travelling away with the same velocity, and thereafter return to his source! But if $D > v'$, then on this double journey method the value for a receding body tends towards the limit $v = c - \frac{u}{2}$ which is simple dynamics. The notion of "hybrid form" is the outcome of ignoring that the method of ascertainment is a method of *the double journey of the messenger.*

44. (ii) *Fresnel's Formula.*

The relative velocity formula *according to the double journey method* is not only a function of the difference between two absolute velocities, but also a function of the individual absolute velocities themselves. It was only as an approximation that it was applied to Fresnel's experiment. For a higher approximation the formula derived on the *messenger's double journey method* would be inappropriate for Fresnel's experiment, because there the two parts of the beam though travelling in opposite directions relative to the moving water perform *only one* and *not a double journey.*

This clears up the discrepancy. The object of the new theory is to explain phenomena by applying well-known rational principles without the postulates of Relativity. So far as Fresnel's water experiment is concerned, he had himself explained it on a simple physical principle of a change in the velocity of light.

45. The transformation formulæ on pages 247–48 have been summarily dismissed as "ridiculous analogues".—They merely indicated a different method of arriving at nearly the same formula, and have not yet been actually applied. The significance of the difference will appear from Chapter VII.

(*b*) *The Principle of Aberration.*

46. "It is difficult to see any justification for the reduction in the intensity of force along its apparent direction. It really makes no sense to say that when the velocity of flow is D, the effective component of force observed along the apparent direction is D cos α."—It makes no sense because the word "apparent" which did not occur in the text (p. 250) has been interpolated. The dynamics of a force moving with a finite velocity is unique, and difficulty of its conception is great. As a matter of fact, it will be seen from Chapters I and VIII that the equations have been obtained on the hypothesis that there is no change in the magnitude along the resultant; and the consideration of a change in magnitude, as pointed out in Chapter VIII, has been postponed.

47. "There is an utter confusion here between velocity and force. This confusion is also responsible for the meaningless phrase 'the velocity of light ON a body moving with velocity v'."—The critic has made a capital out of the misprint in which the word "falling" was unfortunately left out after the word "light".

48. "The claim of universality is belied by assuming that in the case of light the velocity is reduced while in other cases the intensity of force is changed (for example, H in the explanation of Bucherer's experiment)."—The effective magnitude in both of these is changed because it is only their component that is effective.

49. "There is yet another inconsistency .... The universality claimed would certainly require Newton's law of attraction to be $-\frac{\mu}{r^2} : \left(1 + \frac{v^2}{D^2}\right)^{\frac{1}{2}}$ leading on to Gerber's equations, but the author uses, instead, the factor $\left(1 - \frac{v}{D}\right)^3$."—A reference may again be made to the Appendix (IV, pp. 259–60) which shows how the factor is derived. A further reference to Chapter VII, section 5, is invited.

50. The critic says that "it is impossible to see how $c_1 = c \cos \alpha$ and $\tan \alpha = v/c$ can be both simultaneously true where c_1, the apparent velocity of light, has its direction perpendicular to that of v, and α is the angle of aberration".—If the critic means that $c_1 = c \cos\left(\sin^{-1} \frac{v}{c}\right)$ and $c_1 = c \cos\left(\tan^{-1} \frac{v}{c}\right)$ cannot both be simultaneously true exactly, it is of course so. When v is small, the

first approximation gives $c_1 = c\sqrt{1-\frac{v^2}{c^2}}$ which can be transformed into Minkowsky's equation, in which v cannot be greater than c.

But when v is large, $\tan\alpha = v/c$ is the more accurate formula and then the second approximation gives $c_1 = c\cos\left(\tan^{-1}\frac{v}{c}\right)$ which yields

$$c_1 = \frac{c}{\sqrt{1+\frac{v^2}{c^2}}}$$

for which v can be even greater than c, even up to ∞.

51. "It is on the basis of such 'flawless' mathematics that the possibility of velocities up to ∞ is deduced, and one might well suggest to the author the derivation of his first universal principle when one of the bodies is moving with such a velocity, for example, the velocity greater than that of the messenger employed."—Apparently the critic labours under the impression that even when the velocity of recession is greater than that of the messenger the double journey method would hold good. Comment on this is unnecessary, because there can be no double journey in such a case.

(*c*) *Michelson and Morley Experiment.*

52. "By using the author's own universal principles it can easily be shown that this explanation is untenable."—The critic says that the formula should be replaced by

$$\frac{l}{c-\frac{v}{2}} + \frac{l}{c+\frac{v}{2}} = \frac{2lc}{c^2-\frac{v^2}{4}}.$$

(1) This is an obvious misapplication of the formula obtained by *the double journey method* to two *single journeys* of light. If the times for the two journeys to and fro are to be calculated *separately*, the double journey formula cannot possibly be applicable.

(2) If a double journey formula is insisted upon then the *whole* double journey should be taken as one journey and the Corollary (IV, p. 247) which gives the ratio of the apparent and real velocities should be applied, giving instead of the apparent time $\frac{2l}{c}$ the real time $\frac{2l}{c\left(1-\frac{v^2}{c^2}\right)}$.

53. The critic says that the second universal principle has been applied wrongly and that after the direction of flow has been once shifted by an angle α and the velocity changed from c to c_1, "it is therefore wrong to again compound c_1 with v, and hence the time should be replaced by $\frac{2l}{c_1}$".—In reality there is no second compounding at all. When falling on the moving surface the light is shifted forward, and its component along AB′ which alone will reach

$$A'' = c\sqrt{1-\frac{v^2}{c^2}}$$

and the time is given by

$$c_1^2t^2 = l^2 + v^2t^2 \text{ or } 2t = \frac{2l}{\sqrt{c_1^2-v^2}}.$$

In the New Relativity the reflection of light from a moving mirror is different from that from a stationary mirror. The effective incident ray is deflected forward and the effective reflected ray deflected backward by the same angle; but the ray which reaches A″ is the component of the deflected ray along AB′.

54. According to the critic the difference in times should be $-\frac{l}{c}\cdot\frac{v^2}{2c^2}$ which he says "can certainly be measured, but is contradicted by the null result of the Michelson and Morley experiment".—It has been shown above that his deduction of this difference is wrong.

(*d*) "*Fine Structure of Spectral Lines.*"

55. There was no attempt made to give any quantitative explanation, but only an indication was given in anticipation of what was to follow. The critic has wasted unnecessary words on what he naturally regards as "really a complete mystery". It must be so, until the method is announced.

5. COSMOLOGY.

56. "The only positive result is the derivation of Hubble's famous velocity-distance law."—Apparently the validity of the derivation of the equation is not challenged.

57. "This cosmological principle can be considered as a particular form of Milne's principle of equivalent observer's."—This is perhaps some admission that the principle is sound even from the relativitist's point of view, though it is a particular case. In fact my principle of the constancy of the ratio of the acceleration to velocity is quite different from Milne's principle of "equivalent observers".

58. "It is quite redundant for the purposes of deriving Hubble's law to invoke the aid of an emission theory of matter which calls to aid supernatural agencies for the

production of gravitons by the explosion of a sub-atomic shell."—The critic has overlooked section 5 (IV, pp. 236–37) where it is pointed out that the existence of gravitons is not at all necessary for the theory; light corpuscles are in themselves quite sufficient.

59. Starting with de Sitter's observed fact that the velocity of light in free space from the front and the rear of a moving star is the same, the problem was tackled from a purely dynamical point of view as to what would be the effect on the *remaining* mass if light consisted of a swarm of particles. Applying the law of the conservation of momentum and considering as one system a large mass and two particles of light before and after the latter left the former, we get

$mv + Mv + mv = -mc + Mv' + mc$ or

$$v' = \left(1 + \frac{2m}{M}\right)v.$$

This shows that the loss of such particles, when emitted owing to internal action and reaction and moving with nearly constant velocity in free space, causes an increased velocity to the remaining mass.

The critic rejects this simple explanation presumably in favour of the Relativity hypothesis that the nebulæ, though apparently dispersed in a three-dimensional space, are situated on a three-dimensional skin of a four-dimensional continuum, repelled from each other by a cosmic force increasing with the distance, resulting in a general scattering of the universe!

60. The last objection is, to borrow the critic's own words, "truly amazing". The critic by a curious method of "a simple change or (of) origin" concludes that "dR/dt has always the same sign as R, *i.e.*, the velocity is one of recession".—This is indeed marvellous. It means that even if a nebula were really approaching our system, we can by a mere change of the origin turn its velocity into one of recession instead of approach. No words are needed to expose such an elementary error. No doubt R may have any direction with the nebula, but it is always measured along the path of the nebula. On page 235 I made it clear that "if a nebula were moving in a direction making an angle θ with the line of sight from the earth and *R measured along that direction* and r along the line of sight, etc." I should have thought that even the diagram given on that page would have left no doubt.

In the new theory the velocity is not like the speed of gravitation in Relativity where "if co-ordinates are chosen so as to satisfy a certain condition which has no very clear geometrical importance, the speed is that of light; if the co-ordinates are slightly different, the speed is altogether different from that of light. The result stands or falls by the choice of co-ordinates."[15]

In conclusion, I may add that my theory is a very humble attempt to offer a dynamical explanation of the phenomena which alone are the justification for the postulates of Relativity. As it deals with such a variety of matters, I am quite prepared to concede that, even though no real mistake has yet been pointed out, there may be some, which, if rectifiable, would be gladly corrected by me. Indeed, I am myself quite conscious that my equations also are only approximately true. The theory is still in its early stages and therefore quite capable of modification. My earnest request to mathematicians and scientists is to examine the theory with an open and unprejudiced mind, and see for themselves whether anything can be made of it. If it can succeed in offering rational explanations of the mysterious phenomena on well-understood dynamical principles, the necessity for the postulates of Relativity would cease to exist, though its magnificent mathematical structure shall ever remain for our admiration.

S. M. SULAIMAN.

October 30, 1935.

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[1] 1935, **4**, 145-151.
[2] *Proceedings of the Academy of Sciences, U.P.*, **5**, pp. 126–130. See also *Science*, Nov. 1, 1935, pp. 413–15.
[3] Feb. 1935, No. 2, 124.
[4] May 11, 1935, 797.
[5] *Comptes Rendus*, 1926, **182**, 1134.
[6] *Astronomische Nachrichen*, 1931, **241**, 105-112.
[7] *Zeitschrift fur Astrophysik*, 1931, **3**, 195.
[8] *Ergebnisse Der Exakten Naturwissenschaften*, 1931, 129.
[9] *Astrophysikal Journal*, 1928, **67**, 195.
[10] *Proc. Nat. Acad.*, 1925, **11**, 382.
[11] *Astrophysical Journal*, 1933, **78**, 1.
[12] *Space Time and Gravitation*, p. 91.
[13] Eddington, *Relativity*, p. 19.
[14] *Zeitschrift fur Astrophysik*, 1933, **6**.
[15] Eddington, *Relativity*, p. 131.

WHILE thanking you for having given me an opportunity to reply to Sir Sulaiman's

rejoinder to my critical review, I must confess that I do not feel inclined to undertake again a detailed criticism of the rejoinder. The reading of Sir Sulaiman's reply has left me absolutely unconvinced and, if anything at all, has strengthened the opinions expressed in my original review. I think that the worth of any physical theory is to be assessed not by the thoroughness or otherwise of such criticism and counter-criticism but by the positive achievements to its credit. Moreover, Sir Sulaiman has met a large part of my criticism by referring to future work to be published by him and it is perhaps better to wait for these developments, for, the present Sulaiman theory does not explain anything for which Relativity does not provide an answer. There are, however, some points in Sir Sulaiman's reply, which require a reply.

According to Sir Sulaiman, Relativity has been unable to make any substantial progress from any other hand except that of its creator, and even not much from him since 1916 and this shows that it is not the last word on the problems which it claims to solve. It may be pointed out that nobody ever claimed relativity to be the last word on the subject and physics would be dead the moment its theories became last words. It is also difficult to understand the statement that there has been no progress in Relativity since 1916. Most of the modern theoretical physics has been dominated by relativistic principles and the principle of relativistic invariance has been a guiding factor in the formulation of physical laws. The idea which led de Broglie to formulate wave mechanics must really be considered a great triumph of Relativity. The more recent formulation by Dirac of the theory of the electron is another example of an achievement in relativistic theory. The power of this method has been illustrated recently by Kramers in deriving the spin of the electron from purely classical (not quantum) arguments using relativistic invariance.

Sir Sulaiman maintains, in his reply, that the equations $c + v = c$ and $c - v = c$ correctly represent Einstein's law of addition of any velocity to the velocity of light. Now, Einstein's law of addition of velocities is given by

$$v' = \frac{v + u}{1 + \frac{vu}{c^2}}$$

and if, in this, we put $u = c$, we get $v' = c$. Surely this process is not equivalent to writing $c + v = c$.

I have been represented as thinking that a paper which does not use Tensors, Groups and other branches of higher mathematics is not a valuable paper at all. I never said so, but expressed the opinion that such fundamental notions add to the æsthetic value of a paper. Sir Sulaiman claims simplicity for his theory because he does not use such concepts, but the fact is that, in the last analysis, the solution by a series of approximations of a set of differential equations is certainly more complicated than the fundamental notions of tensors, groups, etc.

"Does Nature exist only when seen by man?" asks Sir Sulaiman. I don't know, but the "principle of observables" which has been a guiding factor in modern theoretical physics and has been so ably applied by Heisenberg would appear to suggest that an answer to this question is beyond the realm of physics.

I now come to the *crucial point* of my criticism of Sir Sulaiman's theory, *viz.*, his alternative to the special theory of relativity. In my criticism, I have shown conclusively that this theory when applied to Fresnel's water experiment gives results quite contradictory to experimental values. Sir Sulaiman evades an answer to this by the remark that in this case the double journey method is inappropriate. Again, he states that this method is not applicable to the case $v' = c$. This shows, therefore, that his formulæ are not at all general and that the general double journey method, of which he makes great use, has limitations which can always be manipulated so as to give the results of relativity. The explanation now offered by Sir Sulaiman in his reply indeed makes this part of the subject more difficult to understand than before. It does not, however, surprise him that critics should feel some difficulty in understanding his theory since it is in its early stages of development. He remarks, "of course, what is not grasped must necessarily appear to be confusing." I might as well retort by remarking that what is confusing cannot certainly be grasped!

I might stop at this stage and await the more detailed examination of my criticism which Sir Sulaiman has promised for a later occasion.

B. S. M.

A Modified Gouy's Balance for the Accurate and Quick Measurements of Diamagnetic Susceptibilities.

THE specimen tube of the Gouy's balance has been modified. The modified tube consists of two tubes of which one is sealed and contains paramagnetic substance and acts as a stopper to the other tube in which the diamagnetic substance is taken. At first the pull due to the paramagnetic substance only is noted and then the combined pull due to para- as well as diamagnetic substances together is read (care being taken that the combined pull should be of attraction). By subtracting the combined pull from that due to the paramagnetic substance only, one can easily find out the repulsion due to the diamagnetic substance.

The force acting on the cylinder along its axis is given by :

$$F_x = (x_1 m_1 - x_2 m_2) H_y \frac{\partial H_y}{\partial x} \quad .. \quad (1)$$

where x_1 and x_2 are the mass susceptibilities of the substance and the medium and m_1 and m_2 are the masses of the specimen and the medium occupying the same volume as the specimen, respectively.

If ω_g is the pull due to the empty tube only, then

$$(\omega_g = (x_g m_g - x_a m_{ag}) H_y \frac{\partial H_y}{\partial x} \quad .. \quad (2)$$

where x_g = mass susceptibility of the glass tube.
x_a = ,, ,, ,, medium.
m_g = ,, of the glass tube.
m_a = ,, of the medium displaced by the glass tube.

If ω_p is the additional pull due to the paramagnetic substance, then :

$$(\omega_p + \omega_g) = [(x_g m_g + x_p m_p) - x_a (m_{ag} + m_{ap})] H_y \frac{\partial H_y}{\partial x} \quad .. \quad .. \quad (3)$$

where x_p = mass susceptibility of the paramagnetic substance.
m_p = mass of the paramagnetic substance.
m_{ap} = mass of the medium displaced by the paramagnetic substance.

If ω_{d_1} is the pull due to the diamagnetic substance, then :

$$(\omega_g + \omega_p + \omega_{d_1}) = [(x_g m_g + x_p m_p + x_{d_1} m_{d_1}) - x_a (m_{ag} + m_{ap} + m_{ad_1})] H_y \frac{\partial H_y}{\partial x} \quad .. \quad (4)$$

Subtracting (3) from (4) :

$$\omega_{d_1} = (x_{d_1} m_{d_1} - x_a m_{ad_1}) H_y \frac{\partial H_y}{\partial x} \quad .. \quad (5)$$

Similarly the pull due to some other diamagnetic substance can be found out and

$$\omega_{d_2} = (x_{d_2} m_{d_2} - x_a m_{ad_2}) H_y \frac{\partial H_y}{\partial x} \quad .. \quad (6)$$

Dividing (5) by (6) :

$$\frac{\omega_{d_1}}{\omega_{d_2}} = \frac{x_{d_1} m_{d_1} - x_a m_{ad_1}}{x_{d_2} m_{d_2} - x_a m_{ad_2}}$$

$$\text{or } x_{d_2} = \frac{1}{m_{d_2}} \left[(x_{d_1} m_{d_1} - x_a m_{ad_1}) \frac{\omega_{d_2}}{\omega_{d_1}} + x_a m_{ad_2} \right] \quad .. \quad (7)$$

This equation has been used for calculating the susceptibilities of the substances under investigation.

TABLE I.

Experimental Results.

Substance	$-x \times 10^{-6}$ observed	$-x \times 10^{-6}$ from other authors	
Benzene ..	0·713	0·712	Int. Crit. Tables
Bromobenzene ..	0·517	0·505	Bhatnagar
Iodobenzene ..	0·473	0·471	Int. Crit. Tables
p-Xylene ..	0·704	0·736	Bhatnagar
Nitrobenzene ..	0·498	0·499	Oxley
Anisole ..	0·668	0·672	Pascal
m-Bromotoluene.	0·528	0·546	Bhatnagar
o-Nitrotoluene ..	0·526	0·532	Int. Crit. Tables
Pyridine ..	0·620	0·623	Pascal

The results obtained appear to be quite satisfactory as they clearly correspond with the values given in the tables. The experimental error varies between 0·7—1·0 per cent. The disturbances that are produced by the air draughts can be easily avoided. As for the working of the apparatus is concerned, it is found that there is a distinct improvement over the previous methods as regards simplicity and ease of operation.

The author takes this opportunity of thanking Prof. S. S. Bhatnagar for suggesting this method.

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November 20, 1935.

Magnetic Susceptibilities of Nitric Acid Solutions.

WE have determined the magnetic susceptibilities of HNO_3 solutions for over thirteen concentrations between 4 and 65%, employing a modified form of the Quincke method with photographic recording arrangement, developed by one of us.[1] The advantage of the photographic method lies in the fact that it enables simultaneous and nearly instantaneous records to be obtained for both the standard and comparison liquids, thus eliminating errors due to non-prevalence of identical conditions.

The susceptibility-concentration curve, as shown in the figure, indicates marked departure from the linear relation. As each point on the curve represents the average of a number of readings which agree to within 0·1%, it is believed that these departures from linearity are genuine. The best line drawn through the points cuts the susceptibility axis at a point corresponding to the value of $-0{\cdot}668 \times 10^{-6}$ for water in solution, which is lower than that for water in the pure state ($-0{\cdot}72 \times 10^{-6}$). The gram-ionic

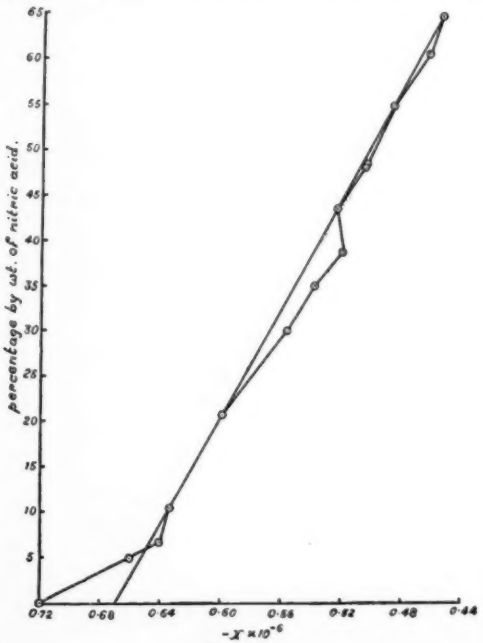

Fig. 1.

susceptibility of the NO_3 ion is found to be $-20{\cdot}83 \times 10^{-6}$ which agrees with the value of $-20{\cdot}1 \times 10^{-6}$ as given by Kido[2] but differs considerably from the value of -38×10^{-6} as calculated by Pauling.[3]

The curve shows four definite minima, corresponding to the compositions, $HNO_3 + 50\ H_2O$, $HNO_3 + 6\ H_2O$, $HNO_3 + 4\ H_2O$, and $2\ HNO_3 + 5\ H_2O$. Although the first minimum cannot be easily accounted for, the other three departures may be attributed to the formation of definite molecular complexes. The existence of such complexes or hydrates has also been indicated by other physico-chemical data, such as freezing point determinations, conductivity, etc. It may be pointed out that the deviations in the case of the last two hydrates are considerably less than those in the first two. This may be explained on the assumption that water which is known to exist in the form of associated molecules is depolymerised at higher concentrations and that the increase in susceptibility resulting from this depolymerisation partly compensates for the decrease, due to the formation of hydrates. Fuller details will be published elsewhere.

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September 16, 1935.

[1] *Indian J. Phys.*, 1931, **6**, 421.
[2] *Sci. Rep. Tohoku Univ.*, 1932. **21**, 149.
[3] *Proc. Roy. Soc.*, 1927, **114**, 181.

The Temperature Coefficient of Susceptibility of Tetra Hydro-Naphthalene.

THE diamagnetic susceptibility of Tetra hydro-naphthalene has been studied at different temperatures, ranging from 23° C. to 25° C., using the Quincke method, with large magnetic fields. The electromagnet used was a large one of the Dubois type. In the experiments, currents used were within 7 amps. and the heating was not appreciable. Care was taken to maintain the current at a particular point. This was effected by having a travelling microscope focussed, on the pointer of an ammeter and any variation of the pointer was corrected by the adjustment of the current, by altering a resistance in parallel with the main circuit.

The tube was thoroughly cleaned first with benzene and then with sodium hydroxide, hot distilled water, and then concentrated nitric acid, and finally with hot distilled water.

The tetralene used in this investigation was kindly supplied in a pure state by Dr. M. Govinda Rau, of the Indian Institute of Science. The tube was filled with the liquid, evacuated and sealed. For observing the depression, a micro-meter eye-piece was used and the usual precautions taken.

The absolute value of susceptibility as determined from the mean of several readings is $-\cdot 688 \times 10^{-6}$. Values were taken at different field strengths and there was no variation with field strength, showing that there was no ferromagnetic impurity.

It is well known that this liquid is highly associated at ordinary temperatures and, therefore, it was thought interesting to study the effect of temperature on this compound. Nitro-benzene and other heavily associated organic liquids have been studied by Dr. Rao and Varadachari,[1] Bhatnagar[2] and Fahlenbrach[3] and the results are not concordant. Dr. Rao has found no change in the susceptibility value, while others find a decrease.

The boiling point of this liquid being 207·8° C., I studied the susceptibility of this liquid, in the range of temperature 23° C. to 70° C. At every temperature, the readings were taken several times and the mean taken as the correct value. It was found that there is no temperature effect on the susceptibility. This is in agreement with Dr. Rao's results that the break-up of association does not produce any change in the susceptibility.

In conclusion, I wish to record my grateful indebtedness to Prof. B. Venkatesachar for valuable guidance and suggestions. My thanks are due to Mr. Sibaiya for useful discussion and criticism.

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December 5, 1935.

[1] *Proc. Ind. Acad. Sci.*, 1934, **1**, 78.
[2] *Ind. J. Phys.*, 1931, **6**, 207; *Phil. Mag.*, 1930, **10**, 101; 1930, **16**, 580.
[3] *Ann. der Phys.*, 1932, **13**, 270; 1932, **14**, 521.

Ageing of Surface of Solutions.

THE effect of age of a surface on its surface tension has been investigated by several workers. They have all employed either methods involving the contact angle or those in which the surface itself would be highly disturbed (*e.g.*, drop weight method). A critical study of available methods revealed that the surface pressure technique developed by Langmuir and Adam is most suitable for studying the phenomenon. This technique has been used in the present work.

A freshly formed surface of M/500 solution of benzopurpurin is shown to exhibit a regular fall of surface tension with time.

Simultaneous with the decrease in surface tension, it has been found that a surface film is produced at the ageing surface as can be detected by pushing the barrier towards the float. If an overcrowding of the surface is effected by pushing the barrier, the surface exhibits an *increase* of surface tension with time. The force-area relations of a five-minute old surface of M/5000 solution of the dyestuff are given in Table I.

TABLE I.

Area in sq. cm.	Surface Pressure in dynes/cm.
420	0
85	1
58	2
42	4
39	6
38	10

The film appears to be more or less of the condensed type. About one-sixth of the ten-minute old surface has been found to be occupied by the dyestuff molecules. The observed rate of accumulation of the solute molecules is far less than the calculated collision frequency, the two values differing by a factor of 10^9. The adsorption appears to be of the activated type. The rate of accumulation is more than doubled for a rise of temperature by 20°. The high temperature coefficient of the rate of accumulation is in accordance with the hypothesis of activation. These studies have been helpful in obtaining the potential energy curves in the neighbourhood of the interface. This technique gives a semi-quantitative method of determining the efficiency of a substance as a foam producer.

The results obtained so far have opened out some new lines of investigation. A detailed account of the work will shortly be published elsewhere.

K. S. GURURAJA DOSS.

Central College, Bangalore,
University of Mysore,
November 25, 1935.

Dehydrogenating Action of Sulphur Monoxide.

IN connection with the work on the mechanism of the chemical action of certain sulphur compounds, we have been studying the properties of sulphur monoxide. The oxide prepared according to the method of Schenk[1] was passed through dry liquid paraffin kept at a low temperature and found to yield hydrogen sulphide. Similar results were obtained when decalin was used for absorption. No hydrogen sulphide was obtained on absorbing the gas in tetrachlorethylene. Sulphur monoxide was found to be comparatively stable in tetrachlorethylene solutions. These solutions yielded hydrogen sulphide with liquid paraffin or decalin. Sulphur monoxide gave hydrogen sulphide readily on treatment with methyl alcohol and more slowly with ethyl alcohol. Using special micro-analytical methods we were able to show that during the production of hydrogen sulphide the methyl alcohol was converted to formaldehyde by the sulphur monoxide in terms of the following equation:

$$2\,SO + CH_3OH = H_2S + HCHO + SO_2.$$

The dehydrogenating action of sulphur monoxide can, in general, be expressed as follows:

$$RH_2 + 2\,SO = R + H_2S + SO_2.$$

The reaction can in some cases be possibly on the lines:

$$RH_2 + SO = RO + H_2S.$$

Further work is in progress.

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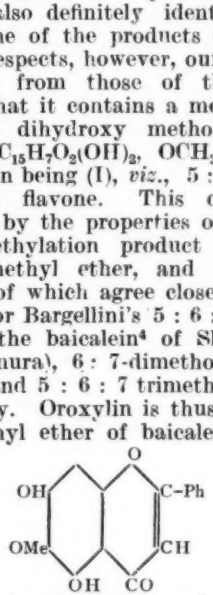
M. R. ASWATHNARAYANA RAO.
Department of Chemistry,
Central College,
Bangalore,
December 8, 1935.

[1] *Zeit. Anorg und. allg. Chemie*, 1934, **220**, 268.

The Constitution of Oroxylin.

"OROXYLIN" (m.p. 225°), the yellow colouring matter, isolated by Naylor and Chaplin[1] from root bark of *Oroxylum indicum* Vent. was investigated by Naylor and Dyer[2] who assigned to it the formula $C_{19}H_{14}O_6$. These authors inferred the presence of three hydroxyl groups from the preparation of an acetyl derivative, assumed to be a triacetyl derivative from the amount of oroxylin recovered from it by hydrolysis. Hydrolysis with alkali gave benzoic acid, a neutral substance, giving colour reactions of phloroglucinol, and phthalic acid. Hydrolysis with dilute alkali is stated to give benzaldehyde. Absence of a methoxyl-group was shown by a negative result for methoxy-determination by Zeisel's method.

We have investigated "Oroxylin" (m.p. 231–32°) isolated from the same source. Our carbon and hydrogen values for oroxylin agree with those of Naylor and Dyer, and we have also definitely identified benzoic acid as one of the products of hydrolysis. In other respects, however, our results differ essentially from those of these authors. We find that it contains a methoxyl group and is a dihydroxy methoxy flavone—$C_{16}H_{12}O_5$, $[C_{15}H_7O_2(OH)_2, OCH_3]$, its actual constitution being (I), *viz.*, 5 : 7 dihydroxy-6-methoxy flavone. This conclusion is confirmed by the properties of nororoxylin (the demethylation product of oroxylin), its monomethyl ether, and its dimethyl ether, all of which agree closely with those recorded for Bargellini's 5 : 6 : 7-trihydroxy flavone[3] (the baicalein[4] of Shibata, Iwata and Nakamura), 6 : 7-dimethoxy-5-hydroxy flavone,[3] and 5 : 6 : 7 trimethoxy flavone[3,5] respectively. Oroxylin is thus shown to be the 6-methyl ether of baicalein.



I

According to previous workers, oroxylin dissolves in dilute alkali with a red colour, which rapidly changes to green. We have established that this is due to an impurity associated in a small quantity with oroxylin, and oroxylin freed from this impurity, is stable to dilute alkali in which it dissolves with a permanent deep yellow colour. The colour reaction of this impurity with alkali indicates that the impurity is baicalein, which probably occurs along with oroxylin.

A detailed account of this investigation will be shortly published elsewhere.

R. C. SHAH.
C. R. MEHTA.
T. S. WHEELER.
Royal Institute of Science,
and
Haffkeine Institute, Parel,
Bombay,
December 8, 1935.

[1] Naylor and Chaplin, *Year Book of Pharmacy*, 1890.
[2] Naylor and Dyer, *J.*, 1901, 954.
[3] Bargellini, *Gazetta*, 1919, **49**, ii, 47.
[4] Shibata, Iwata and Nakamura, *Acta Phytochim*, 1923, **1**, 105.
[5] Hattori, *Acta Phytochim*, 1930, **55**, 99.

Germination of Leguminous Seeds and Urease Activity.

THE enhanced urease activity accompanying the germination of urease-containing seeds[1,2] may be due to (1) an increase in the absolute quantity of the enzyme, (2) an elaboration of activators or elimination of inhibitors and/or (3) a greater extractability of the enzyme. A series of experiments designed to test these possibilities was carried out in which the activities of the aqueous extracts of defatted powders were compared with those of the powders themselves.

0·1 g. of the powder or a quantity of the extract corresponding to 0·1 gm. of powder, was incubated for 30 minutes with 10 c.c. of a 1·0 per cent. solution of urea (in phosphate buffer of pH 6·9) at 30°·0 C. and the ammonia liberated was estimated by the aeration method. The results obtained are tabulated below.

TABLE I.

(Urease Activity expressed in mgms. of Ammonia Nitrogen.)

Seed Material	Extract		Powder–100 mesh	
	U.G.*	G.‡	U.G.*	G.‡
Dolichos biflorus, Linn.	2·4	8·7	8·5	9·0
Glycine hispida (Mœnch)	5·4	8·2	9·7	9·6
Cajanus indicus, Spreng.	5·7	8·2	8·1	8·5
Canavalia ensiformis, Dc.	19·1	27·3	26·1	28·1

*U.G. = Ungerminated.
‡G. = Germinated.

The results show (1) that the activities of the germinated seed extracts are invariably greater than those of the ungerminated seed extracts, and (2) that in the case of powders, the differences between the activities of germinated and ungerminated seed materials are not marked. The activities of the powders represent the total urease content of the seed, as the enzyme is capable of acting on its substrate in the absorbed state.[3] Calculated on the basis of the activities of powders, the percentage of extractable urease is above 95 in the case of germinated seeds, and less than 70, in the case of the ungerminated seeds. Activators and paralysers, if present, will influence the activities of both extracts and powders equally.

These considerations lead to the conclusion that part of the urease exists in the seeds in an adsorbed and unextractable condition—*desmo*-urease, and that during the process of germination, it is converted into an extractable, *lyo*-form. Further work is necessary to characterise the two forms of urease.

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B. A. SUNDARA IYENGAR.
Department of Biochemistry,
Indian Institute of Science,
Bangalore,
December 4, 1935.

[1] Yutaka Jono, *Acta. Schol. Med. Univ. Imp. Kyoto*, 1931, **13**, 211.
[2] Wei Sun Tao and Shigeru Komatsu, *Mem. College of Sciences, Kyoto Imp. Univ.*, Ser. A, 1931, **14**, 233.
[3] Przylecki, Niedzwiedzka, and Majewski, *Biochem. J.*, 1927, **21**, 1026.

Ascorbic Acid Oxidase from Drumstick, *Moringa pterygosperma*.

IT has been shown[1] that extracts from different plants exhibit great variations in the rate of oxidation of ascorbic acid. As resistance to oxidation was usually shown by extracts which contained reducing substances other than ascorbic acid, it was inferred that such substances exerted a protective action on the acid. An example of a material in which ascorbic acid was extremely stable to oxidation and which contained a large proportion of substances titrating against iodine but not against Tillmans' reagent, was the press juice of the Indian gooseberry, *Phyllanthus emblica*. In order to examine if this juice contained protective substances, it was decided to try the effect of its addition to the press juice of drumstick, *Moringa pterygosperma*, which on account of the identity of iodine and Tillmans' titres, was known to contain ascorbic acid as the only reducing substance. The surprising result was, however, obtained that, in contradistinction to trichloroacetic acid extracts of drumstick, its *press juice* did not reduce 2 : 6-dibromophenol-indophenol; further, that the juice rapidly oxidised the reducing factor in gooseberry or in orange juice, as also solutions of ascorbic acid (B.D.H.). It was also found that if the intact drumsticks were immersed in boiling water for a short time, press juice containing the usual amount of ascorbic acid could be obtained. Thus, in drumstick juice, the presence of an enzyme system capable of

oxidising ascorbic acid and which was inactivated either by boiling, or by treatment with trichloroacetic acid, was clearly indicated. Such a system, termed "hexoxidase" was shown to be present in cabbage juice by Szent-Györgyi in 1931.[2] Recently,[3] the isolation of an ascorbic acid oxidase from *Cucurbita maxima* was reported.

A preparation of the enzyme from drumstick was obtained as follows:—The press juice was centrifuged, the supernatant liquid treated with 5 per cent. ammonium sulphate (solid) and left in the ice-chest overnight. Next morning, the heavy precipitate that had formed was filtered off and the active filtrate further treated with ammonium sulphate to 35 per cent. final concentration (about 75 per cent. saturation). The resulting fine precipitate was separated by centrifuging, dispersed in a small volume of water (about a sixth of the original volume of press juice) and filtered. Thereby a clear yellow filtrate possessing very powerful oxidising action was obtained.

The action of the enzyme was studied with ascorbic acid as substrate at the optimum pH of 5·3 (9·75 ml. primary + 0·25 ml. secondary phosphates according to Sorensen) at 37° C. The amount of ascorbic acid present at any time in the reaction mixture was determined by titrating the latter against standard solution of 2 : 6-dibromophenol-indophenol. In a typical experiment, 0·1 ml. of the enzyme solution, obtained as above, was found to completely oxidise 0·4 mg. of ascorbic acid to its reversible oxidation product in 3 minutes in a total volume of 5 ml. From studies so far made of the kinetics, it appears that the reaction is monomolecular and the rate of oxidation is directly proportional to the quantity of enzyme and independent of substrate concentration.

At low concentrations of cyanide and H_2S (10^{-3} M) the enzyme is greatly inhibited, which thus differs from the enzymes obtained by Szent-Györgyi (*loc. cit.*) or Tauber and co-workers (*loc. cit.*).

Guaiacum, catechol, pyrogallol and *para*-phenylenediamine were not oxidised by the enzyme preparation except in the presence of H_2O_2. This peroxidase action exhibited by the preparation is, however, totally unconnected with the oxidative mechanism which does not require H_2O_2 for its action. That the ascorbic acid oxidase acts independently of the co-existing peroxidase was also shown by the complete disappearance of peroxidase activity in presence of 10^{-4} M cyanide, when the oxidising action was still very definite. Further, alcohol and acetone were found to destroy almost completely the ascorbic acid oxidising constituent, but left the peroxidase unaffected.

These results confirm the findings of Tauber *et al.*[3] that there exists in plants, apart from the complex mechanism postulated by Szent-Györgyi (*loc. cit.*) and by Szent-Györgyi and co-worker[4], a specific enzyme capable of oxidising ascorbic acid.

M. SRINIVASAN.
University Biochemical Laboratory,
Madras,
December 4, 1935.

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[1] Damodaran and Srinivasan, *Curr. Sci.*, 1935, **3**, 553; *Proc. Ind. Acad. Sci.*, 1935, **2 B**, 377.
[2] Szent-Györgyi, *J. Biol Chem.*, 1931, **90**, 385.
[3] Tauber, Kleiner and Mishkind, *J. Biol. Chem.*, 1935, **110**, 211.
[4] Szent-Györgyi and Vietorisz, *Biochem. Z.*, 1931, **233**, 236.

A New Apparatus for Carbonic Acid Estimations in Soils.

GASOMETRIC estimations of carbonic acid in soils are generally carried out with the apparatus designed by Collins. Although convenient for many purposes, Collins's Calcimeter suffers from certain inherent defects. The intervention of a rubber tubing between the reaction flask and the measuring burette may occasionally cause considerable errors. As one end of the tube adjacent to the measuring burette is open to the air, the instrument is very sensitive to atmospheric pressure fluctuations. To circumvent these difficulties, an apparatus for carbonic acid determinations has been developed in this Laboratory. This apparatus is independent of atmospheric pressure variations, and the use of a modified Thunberg[1] tube for the reaction makes it possible to mix the reactants very effectively. The apparatus can also be employed for the study of physiological functions provided the experiments are to be carried out at the room temperature.

The principle of the apparatus (Fig. 1) is the same as employed by the authors for another purpose.[2] The amount of CO_2 evolved will be proportional to the increase of pressure in the reaction bulb. If h is the increase of pressure in mm. of Brodie solution and x is the amount of CO_2 evolved in c.mm. at N.T.P. (dry), we have

$$x = h\left(\frac{V_g\frac{273}{T} + V_f a}{P_0} + A\frac{273}{T}\right),$$

where V_g = c.mm. gas in the bulb down to the "O" mark on the manometric tube,
V_f = c.mm. acid in reaction bulb,
a = Bunsen absorption coefficient of CO_2,
P_0 = pressure of one atmosphere expressed in mm. of Brodie solution,
A = area of cross-section of manometer tube in sq. mm.

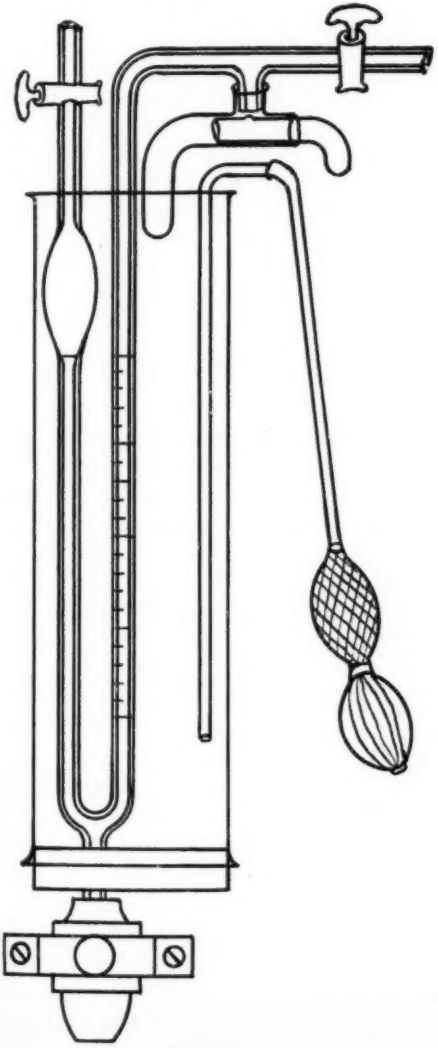

Fig. 1.

Having obtained the amount of carbon dioxide evolved in c.mm. at N.T.P. the percentage of carbon dioxide in the soil is easily computed. One c.mm. of carbon dioxide at N.T.P. weighs 0·001977 mgm., and the percentage by weight of carbon dioxide in the original sample, say x, is given by the following formula :

$$x = \frac{V \times 0{\cdot}1977}{w}$$

where V = volume of carbon dioxide in c.mm. at N.T.P.
w = weight of the sample in mgm.

The accuracy of the apparatus is $\pm$ 1·25 per cent. The various details as to construction, manipulation and computation will appear elsewhere.

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P. B. MATHUR.
Institute of Agricultural Research,
Benares Hindu University,
August 16, 1935.

[1] Thunberg, *Skand. Arch. Physiol.*, 1927, **35**, 163.
[2] Singh and Mathur, *Biochem. J.* (in course of publication).

Relative Wood Preservative Efficiency of the Tri- and Pentavalent Forms of Arsenic.

ALTHOUGH it has been unanimously accepted that arsenic, in all its forms, is highly toxic and is an efficient wood preservative, there has been considerable divergence of opinion on the question of the relative wood preserving efficiency of tri- and pentavalent compounds of arsenic. For example, Kunkel[1] mentions that pentavalent arsenic is less poisonous than trivalent arsenic.

The writer has had for over 42 months several test specimens of wood, of 12 species, that were treated with two different concentrations 1½ per cent. and 2½ per cent. in aqueous solution of As_2O_3 and of As_2O_5. The specimens were 24″ long, 2″ × 2″ in cross-section. They were impregnated under identical conditions of pressure (in the cold) with the above solutions. The treated pieces were allowed to air-dry, and then laid down in the antiseptic test-yard of the Forest Research Institute, Dehra Dun. The average annual rainfall in the region of the test is about 80 to 100 inches. In the case of the specimens treated with 2·5 per cent. of As_2O_3 and of As_2O_5, there is practically no difference in the present condition of the test pieces. 7 out of 12 have been destroyed in each case. One has been moderately white-ant and fungus attacked, and the rest

have been slightly fungus attacked. All the 12 untreated controls have been destroyed within 42 months.

As regards specimens treated with 1·5 per cent. of As_2O_3 and As_2O_5, the results are slightly in favour of the latter.

In view of the above, and despite the much greater tendency of As_2O_5 (as compared to As_2O_3) to leach out of wood, it would appear that the wood-preserving efficiency of As_2O_5 against termites and fungi is not inferior to that of As_2O_3.

S. KAMESAM.

Forest Research Institute,
Dehra Dun,
December 3, 1935.

[1] *Handbuch der Toxikologie*. Jena, 1901, p. 262.

Tuberculation of Water Pipes.

THE views held by different investigators with regard to the formation of tubercles in pipes are rather conflicting. Most of the earlier workers[1] consider that the tubercles are simple chemical precipitations. A few of them have also suggested that iron organisms like *Leptothrix*, *Gallionella*, *Cladothrix*, *Crenothrix*, and *Spirophyllium*, when present, play only a very subordinate or secondary rôle in the formation of these nodular excrescences. Other authors[2] have stated that tubercular incrustations are solely due to the abstraction of iron by *Gallionella*, *Leptothrix* and *Spirophyllium*. It also appears that many of the earlier workers have confused the slow appearance and steady development of the tubercles or "limpet" like structures with the sudden visitations[3] of the filamentous forms like *Crenothrix* and *Cladothrix* that occasionally occur in water reservoirs and conduit pipes. The persistence of tubercles inside the pipe, in spite of the incessant flow of water through it, has not been adequately explained.

With a view to studying the relation between the tubercle and the surrounding water in the pipe, a detailed chemical and bacteriological analysis of some of the tubercles was carried out as also a set of samples of water taken from different parts of a town supply system.

TABLE I.

Chemical Composition of Tubercles in Cast Iron Pipes.*

Constituent	Percentages on dry weight							
	Samples							
	I	II	III	IV	V	VI	VII	VIII
Iron (Ferrous as FeO)	3·7	4·6	3·1	2·1	6·7	6·4	8·2	2·4
Iron (Ferric as Fe_2O_3)	69·5	68·5	68·7	65·0	67·9	70·7	72·0	66·0
Aluminium (as Al_2O_3)	7·6	8·2	9·8	12·1	6·2	8·0	7·5	12·7
Silica	6·0	5·7	3·1	3·3	6·6	5·9	3·9	3·4
Phosphoric acid (as P_2O_5)	0·2	0·1	0·4	0·4	0·1	0·3	0·2	0·3
Manganese (as MnO_2) .. .	0·2	0·1	0·2	0·4	0·6	0·2	0·2	0·7
Calcium (as CaO)	1·3	1·4	0·8	0·7	1·8	0·9	0·6	0·7
Magnesium (as MgO)				Traces				
Total nitrogen	0·05	0·05	0·14	0·20	0·09	0·11	0·08	0·15
Total carbon	1·96	1·65	3·57	5·28	1·21	1·22	1·06	2·20
Loss on ignition	8·8	8·4	12·8	11·5	9·2	8·7	9·2	11·7
Moisture content	15·57	17·44	6·83	36·79	29·48	34·87	37·56	3·93

I. Collected from dead end of the main containing filtered and chlorinated water for washing the filter units.

II. Similar to I, but collected from a different end.

III. Collected from the leading main to the General Hospital.

IV. Collected from a hatch box in the 9″ water main carrying filtered water.

V. Collected from a hatch box in the 30″ water main carrying raw river water.

VI & VII. Similar to V, but collected from different portions of the water main.

VIII. Collected from an old pipe which was cut out from the Distribution System from near the Power House. The main is 8″ in diameter.

* The samples were obtained through the courtesy of the Water Works Engineer, Trivandrum (South India) to whom the author's thanks are due.

TABLE II.

Chemical Analysis of Samples of Water from Different Parts of the System.

Sample	Parts per 100,000				
	P_H	Total Solids	Loss on Ignition	Iron	Aluminium
I	6·9	35·80	31·60	0·102	Traces
II	7·8	14·80	6·05	0·099	do.
III	7·5	11·40	7·60	0·150	do.
IV	7·5	8·50	5·12	0·165	do.

I. Raw river water, *i.e.*, the source of water supply (Trivandrum Water Supply).

II. Water of the same sort as Sample No. I, but treated with lime and allowed to settle for about 8 hrs.

III. The same water that has been filtered but not chlorinated.

IV. The same water filtered and chlorinated: representative sample of the street tap water collected from a tap about 2½ miles away from the Filter House.

From the foregoing tables, it will be observed (1) the tubercles collected from the particular system are more or less similar in their chemical composition; (2) iron in the ferric condition is the chief constituent, while, aluminium, silica, ferrous iron, calcium, magnesium, manganese, and phosphate are present in much smaller proportions: organic carbon and nitrogen are also present in small quantities; (3) the iron necessary for the formation of the tubercle comes mostly from the pipe itself, while the water passing through the pipe system supplies the other constituents. It is more than likely that a large proportion of the silica, phosphorus, manganese, and carbon is derived from the pipe, for, cast iron contains these in appreciable quantities; (4) there is a slight, but apparently progressive increase in the content of the water, as the water passes through the pipe. This would show: (*a*) iron from the pipe passes into solution in the water and (*b*) the iron of the tubercle does not therefore appear to be from the water but is mainly derived from the pipe itself; (5) the tubercles examined contain none of the better known iron bacteria,[4] but they are invariably associated with a lower form of fluorescent bacillus of the *pseudomonas* type which is derived from the water.

Direct experiments carried out with pieces of cast iron pipes, with and without a protective covering, show that tubercles appear at points bare of the coating already exposed or where as often happens the protective coating has been removed by the flow of water. A coating of tar or asphalt *does offer* some protection but that would appear to be only temporary. Even small pin points in the coating through which the iron is exposed are sufficient to start rusting which will soon be followed by tuberculation. Rusty layers do not, however, assume any definite proportions. They can be and are often partially flushed out by a vigorous stream of water. Tubercles, on the other hand, have definite conical or dome-like shapes, grow out prominently and persist even when a strong current of water is flowing through the pipes. This remarkable behaviour would appear to bear some relation to the occurrence of the *pseudomonas* which flourishes in the rusty layers and probably helps to cement them together so as to produce ultimately the characteristic tubercular structure studied by us.

The most interesting feature about this bacterium is its ability to live and grow in rust; by repeated sub-cultures in media containing pieces of metallic iron, pure strains of the organism could be easily isolated. Rusting of only a moderate nature is observed when filtered and chlorinated water is passed through the pipes. If, on the other hand, either ordinary filtered water or sterile water artificially infected with the specific organism is circulated, the rate of rusting is increased, tuberculation also sets in rapidly and in a few weeks the entire inner surface of the pipe is found dotted with incrustations.

Further work is in progress with a view to (1) identifying the associated organism and studying its physiology and the precise manner in which it contributes to the formation and persistence of tubercles, and (2) devising improved methods for providing the interior of pipes with protective coating which would resist rusting and subsequent formation of tubercles.

The author wishes to thank Prof. V. Subrahmanyan for his keen interest in the work.

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Department of Biochemistry,
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Bangalore,
October 12, 1935.

[1] Brown, C., *Proc. of Institution of Civil Engineers*, 1903–04, Part II; Casagrandi, O., *Instituto d' igiene della R Universita di Cagliari*, 1913.

[2] Schorler, B., *Centralbl. fur Bakt.*, 1904, Abth. II.

Bd. 12; Redington, H. R., *et. al.*, *Jour. Amer. Water Works Assoc.*, 1931, **23**, 1650-93; Naumann, E. Z., *fur* Gesund-heitstech U. Stadtehyg., 1933, **25**, 34.

[3] Hirst, L. F., *Biology of Colonbo Water Supply*, 1928, 209-210; Gaffey, A., *Water and Water Engineering*, 1931, **33**, 12; Brown, K. W., *Jour. Amer. Water Works Assoc.*, 1934, **26**, 1684.

[4] Ellis, D., *Iron Bacteria*, 1919, 147-154.

Chromosome Numbers in Safflower—*Carathamus tinctorius*, Linn.

GREGORY, P. J. (1935)[1] has reported from the study of the somatic mitosis the $2n$ number in Safflower as 20. The authors of the note who worked with Pusa type 24 made several counts in metaphase plates of somatic and meiotic mitoses. These revealed 24 chromosomes for $2n$ and 12 bivalents for n respectively.

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November 15, 1935.

[1] *Proc. Ind. Acad. Sci.*, 1935, **1**, No. 11.

WITH reference to the above note regarding the chromosome numbers in Safflower (Pusa Type 24), I would like to report on the results so far derived in my present investigation of the chromosome studies of the different Pusa types of Safflower. Of these, I have so far been able to ascertain the chromosome numbers in two Pusa types (Types 1 and 27), both of which gave the $2n$ number of chromosomes as 24. So, it is fairly certain that the chromosome numbers in Pusa types of Safflower is $2n = 24$. In this connection I would like to add that the varieties I have investigated and published in my previous paper on Safflower (Gregory, P. J., 1935),[1] were distinctly the Coimbatore types and as far as the somatic counts were concerned, the $2n$ number was 20 in those cases. It may be that the variation in chromosome numbers noted above is due to a varietal difference between the Coimbatore and Pusa types of Safflower. Only further investigation, which is now proceeding, can clearly explain the exact cause of this variation.

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Agricultural Research Institute,
Lawley Road P. O., Coimbatore,
December 9, 1935.

[1] *Proc. Ind. Acad. Sci.*, 1935, **1**, No. 11.

On Some Abnormal Flowers of *Hibiscus Rosa-sinensis*.

IN October 1933 the author collected a number of abnormal flowers from some plants in a private garden in Sagar, Mysore State. The owner of the garden had grown them from cuttings he had brought from some place on the West Coast.[1] All the flowers borne on these plants were abnormal.

Abnormality is seen in the three inner whorls, the corolla, the androœceum and the gynœceum. The calyx is normal, with five

Fig. 1. L. S. of flower.

Fig. 2. A Stamen.

lobes; and the epicalyx consists of seven lobes.

The phenomenon known as *positive dédoublement*[2] is seen in the corolla, which consists of five whorls of petals, twenty-seven in all being seen in the transverse section shown in Fig. 3. The outermost whorl has the typical twisted æstivation, the second interpenetrates with the first, and the inner petals are folded in a complicated manner.

The normally monadelphous staminal tube (which is theoretically believed to be composed of five fused epipetalous members)[3] has split up into six stamens so that even here there is an increase in number. Each of these six stamens bears an indefinite number of one-celled anthers on connectives (Figs. 1 and 2). This splitting up of the staminal tube known as *Dialysis*[4] has been recorded in Hollyhock (*Althæa rosea*).

The ovary is also abnormal, the carpels having been converted into petaloid structures. This type of metamorphosis has been termed *petalody*.[5]

This combination of the three above-mentioned abnormalities in *H. Rosa-sinensis* is interesting and has not been recorded before,[6] although this species has been known to show diverse kinds of abnormalities. These phenomena are generally regarded as reversionary.

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Department of Botany,
University of Lucknow,
November 23, 1935.

Fig. 3. T. S. of bud. ×5.

[1] There is a plant showing the same type of abnormal flowers in Lalbagh, Bangalore.

[2] Worsdell, W. C., *Principles of Plant Teratology*, 1916, Vol. II, 59.

[3] In the normal flower of the Malvaceæ "the fertile stamens are generally very numerous and are considered to have arisen by the multiplication of five epipetalous members".—(Rendle, A. B., *The Classification of Flowering Plants*, 1925, Vol. II, 249.)

[4] Worsdell, W. C., *loc. cit.*, p. 113.

[5] Worsdell, W. C., *loc. cit.*, p. 204.

[6] Worsdell, W. C., *loc. cit.*; Masters, T. M., *Vegetative Teratology*, 1869; Penzig, G., *Pflanzen-Teratologie*, 1921, **Band 2**; Singh, T. C. N., "Teratology of Indian Plants," *Jour. Indian Bot. Soc.*, 1935, **14**, No. 4.

A Preliminary Note on the Development of the Female Gametophyte in *Costus speciosus* L.

IN a recent article Maheshwari[1] has reviewed the work on the embryology of angiosperms that has been done in India and suggested a re-investigation of certain genera including Costus. Previous investigation on this line on *Costus speciosus* L. was carried out by Humphrey[2] who suggested a "Lilium type" of embryo-sac development.

The results of our investigation show that an archesporial cell is developed in the hypodermal layer of the nucellus, it cuts off a parietal cell and then functions as the megaspore mother-cell. The megaspore mother-cell increases in size before division. In the stages of the heterotypic prophase the nucleus, in some preparations, is observed to lie at the lower end of the protoplast (Fig. 1). The heterotypic spindle, however,

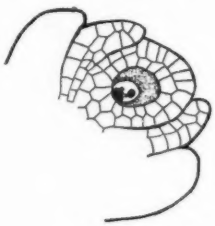

Fig. 1. × 375.

is oriented centrally and is quite sharp. A cell plate is noted on the completion of the reduction division. The homotypic spindles are arranged somewhat obliquely and as a result four obliquely-oriented tetrad of macrospores is formed (Fig. 2). The chalazal

Fig. 2. × 250.

macrospore alone functions while the rest degenerate. The mature embryo-sac is eight-nucleate and is of the normal angiospermic type. The antipodals later degenerate.

The development of the embryo and the endosperm is being worked out and some interesting stages in the development of the endosperm have been obtained. A detailed account of the complete investigation will be published elsewhere in due course.

I. BANERJI.
V. VENKATESWARALU.

Botanical Laboratory,
Calcutta University,
November 28, 1935.

[1] Maheshwari, P., *Curr. Sci.*, 1935, **3**, 599-605.
[2] Humphrey, J. E., *Ann. Bot.*, 1896, **32**, 1-40.

On an Abnormal Flower of *Convolvulus pluricaulis* Chois.

ONE of the flowers of *Convolvulus pluricaulis* Chois. (= *Evolvulus pilosus* Roxb.)[1] examined during a practical class showed an apparently fertile anther attached to one of the two stigmatic branches of the style (Fig. 1).

Fig. 1. × 4.

The anther is practically sessile and of the same shape and size as the other anthers of the flower. Though it had dehisced like the others, there were just two pollen grains inside and these were exactly like the normal pollen grains; the anther was obviously fertile. Serial sections of the specimen showed no suggestive differences in the internal structures of the two stigmatic branches.

Parts of the pistil being substituted by or transformed into anthers are on record and described under "Staminody of the Pistil".[2] Anthers surmounting the pistil have also been noted in a few plants.[3] Worsdell[4] records the case of an abnormal flower of *Linaria vulgaris* where, in addition to other

abnormalities, imperfect anthers were borne on the style. Baillon's[5] description of "stigmas of *Ricinus communis* as having been in one instance antheriferous" furnishes another close parallel. All the above cases are supposed to be examples of Metamorphosis. On the other hand, adhesion of carpelloid or even untransformed stamens to pistils is quite common and is described under the category of Adnation.[6]

I am inclined to consider the specimen under consideration as an example of the latter category. So far as I know this abnormality has not been recorded in the family Convolvulaceæ.

My best thanks are due to Mr. O. N. Tyagi of the First Year B.Sc. Class who drew my attention to this exceptional flower.

A. R. RAO.

Department of Botany,
University of Lucknow,
November 23, 1935.

[1] Hooker, *Flora of British India*, 1885, Vol. iv, 218; Duthie, *Flora of the Upper Gangetic Plain*, 1911, Vol. ii, 105.

[2] Masters, *Vegetable Teratology*, 1869, 299.

[3] Masters, *loc. cit.*, 300.

[4] Worsdell, *The Principles of Plant Teratology*, 1916, Vol. ii, 206.

[5] Masters, *loc. cit.*, 300; Penzig, *Pflanzen-Teratologie*, 1922. Vol. iii, 209.

[6] Masters, *loc. cit.*, 35; Worsdell, *loc. cit.*, 236, 37.

The Kaldurga Conglomerates and the Iron Ore Series of the Bababudans, Kadur District, Mysore.*

REFERRING to the recent papers on the Bababudan rocks published by Mr. C. S. Pichamuthu,[1] I should like to offer a few remarks regarding the Kaldurga conglomerates and the Iron ore series of rocks.

The Kaldurga conglomerates were originally considered to be sediments by Bruce Foote,[2] Wetherell[3] and Smeeth,[4] but as a result of later examination Slater[5] and Smeeth[6] doubted the sedimentary origin. Subsequently, Sampat Iyengar[7] mapped the region in great detail and came to the conclusion that they were of autoclastic origin. Whether these rocks can finally be proved to be sediments or not, is difficult to say at present, but a critical examination of some of the arguments put forward by Pichamuthu shows that more than one opinion is still possible on the subject, and the evidences he has adduced are not sufficiently strong and convincing to accept a sedimentary origin for all these formations.

Many of the features such as the shape and rounding of the pebbles, sharp boundary between pebble and matrix, varied assemblage of pebbles, the difference between pebble and matrix and alternation of pebbly and non-pebbly bands, etc., are not entirely wanting in conglomerates which could be shown to be of autoclastic origin. Pichamuthu's argument[8] that the granite pebbles do not contain orthoclase or microcline (implying thereby that the intrusive Tarikere granite is not represented as pebbles in the conglomerates) appears to be based on insufficient examination. Sampat Iyengar laid much emphasis[9] on the similarity between the granite of the conglomerate and the Tarikere gneissic granite. A re-examination of the material collected by him bears out his conclusions. In the granite pebbles collected by him from the temple boulder[10] (Z_4/862, 866, etc) both orthoclase and microcline are found, though only to a limited extent. When the granite is subjected to crushing and shearing, it is only natural to expect an alteration of the felspars, the albite remaining over as the more stable under metamorphic conditions whereas orthoclase would get converted into sericite and muscovite. Sericite is no doubt found largely in the granitic pebbles and they might have been formed from the alteration of the potash felspars.

B. Rama Rao, in the course of his detailed examination of the Shimoga Belt during the last field season, has obtained many distinct evidences of ripple marks, current bedding, rain prints and other undoubted indications of sedimentation in the quartzites and some of the conglomerates of that region. It may be probable that even the Kaldurga conglomerate has had a sedimentary origin, but the evidences adduced by Pichamuthu are not strong enough to warrant such an assumption. Moreover, the evidences for shear and crushing are clearly indicated and it remains yet to be proved if this has taken place in a pure sedimentary conglomerate, or in a complex of igneous rocks, or even in a mixed series of igneous rocks and sediments. The evidences now available, however, do not justify a hasty conclusion and the inference that the Tarikere granite has played no part in the formation of the "Granite Pebbles" of the Kaldurga conglomerates is unwarranted. The question of the precise mode of origin of these rocks

* Published with the permission of the Director, Mysore Geological Department.

merits a considerably more detailed investigation from various aspects than what has been done at present.

The geological section[11] drawn across the Kaldurga conglomerate represents a syncline near the Kaldurga hill and an overfold near the Nandi-Hosahalli valley. The map, however, indicates only the direction of the dips in some places and their magnitude is not known. Sampat Iyengar's original map shows that the dips are not consistent over any large area, particularly in the eastern band, though the general trend in the western bands is eastwards and that of the masses to the south of Nandi is north to north-north-eastwards. In the absence of a systematic mapping of the formations into definite beds, the interpretation of the precise tectonic features becomes very difficult. While the synclinal structure yet remains somewhat doubtful, the overfold need not be assumed at all. The separation of the schists may have taken place by stoping away of a portion of the tilted general succession by the intrusive granite exposed in the Nandi-Hosahalli valley.

The problem of the ferruginous quartzites again confronts us with many difficulties and the arguments of Pichamuthu offer no conclusive proof either, of a sedimentary origin. For instance, the dominance of MgO over CaO together with that of Fe_2O_3 over FeO has been claimed to be a positive indication[12] but one may as well argue, from the same analyses, that the dominance of Na_2O over K_2O, if taken into consideration, does not support such a contention.[13] It has been assumed that the sediments were derived from spilitic rocks, but these have neither been mapped nor shown to exist in any large masses. Judging from the descriptions,[14] they are only of a local development and do not appear to be very different from the Lingadhalli and Santaveri Traps. The chemical analyses of these latter, however, do not show any large percentage of Na_2O and the assumption of a spilitic suite requires yet to be proved.

The occurrence of "interformational folding" has been claimed to be noted in the ferruginous quartzite and taken to be a very good proof of sedimentation.[15] It is doubtful if these bandings can be taken to be true bedding or deposition planes. Bandings are noted to have originated in several ways and in these rocks metamorphism has obviously played a great part in producing many structural and mineralogical changes. Pichamuthu himself notes as one of the effects of igneous intrusion[16] "the banding of the rocks have been emphasised and the iron stones in the neighbourhood recrystallised." Anyway, it is difficult to place much reliance on a few isolated structural peculiarities and accept them as definite proof of sedimentary origin.

The finding of the Fossilwood[17] in the Iron ores is very interesting, particularly in view of the fact that these rocks have formed under conditions totally different to those that gave rise to the banded ferruginous quartzites. Until more material and information are obtained, we can draw no satisfactory conclusions.

That Bababudanite is of secondary origin and not an original constituent of the amphibolites was pointed out by Jayaram[18] as far back as 1923. He then opined that the amphiboles were derived from the alteration of impure calcareous grits and tuffs. Apparently, Pichamuthu also shares with Jayaram the view regarding the secondary character of bababudanite, but the precise mode of development of this mineral yet remains a doubtful point. In an earlier communication Pichamuthu and M. R. Srinivasa Rao[19] suggested that the amphiboles have developed at the intrusive contacts of the traps with the iron ore rocks and that they had little or nothing to do with the origin of the latter. But this view has been subsequently modified. Pichamuthu[20] now regards the bababudanite-magnetite schists as due to metamorphic differentiation of sediments derived from the spilitic rocks. As already remarked, the existence of spilites has not been proved, though it appears likely we have, in this region, some keratophyres and soda felsites (Galipuje Felsite). But, the relationship of these with the banded iron ore series is not definitely known.

Regarding the age relationship between the Tarikere and the Bababudan series, Pichamuthu agreeing with the inferences of Smeeth and Sampat Iyengar states that "the Tarikere series is younger than the Bababudan series not because of its intrusive character, but considering the stratigraphic sequence".[21] But the original maps reproduced in his papers with slight modifications do not lend support to this inference. The Kaldurga conglomerate does not appear to be a basal formation and whether the Tarikere and Bababudan series are marked by any unconformity or not is unknown and much more detailed work will be necessary

before we can come to any definite conclusion on these and other controversial points.

M. B. RAMACHANDRA RAO.

Mysore Geological Department,
Bangalore,
December 6, 1935.

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[1] C. S. Pichamuthu: *Proc. Indian Acad. Sci.*, 1935, **2**, (3), 254-277; *Curr. Sci.*, 1935, **3**, 606-608. *Half-Year. Jour. Mys. Uni.*, 1935, **8**, No. 1.
[2] R. B. Foote, *Mem. Mys. Geol. Dept.*, I, pp. 29-31.
[3] E. W. Wetherell. *Rec. Mys. Geol. Dept.*, IV, 92-98.
[4] W. F. Smeeth, *Rep. Chief. Ins. of Mines in Mysore*, 1901, p. 18.
[5] H. K. Slater, *Rec. Mys. Geol. Dept.*, VII, Pt. 2, p. 4.
[6] W. F. Smeeth, *Rec. Mys. Geol. Dept.*, XIV, Pt. 1, pp. 25-26
[7] P. Sampat Iyengar, *Rec. Mys. Geol. Dept.*, XV, Pt. 2, pp. 106 116.
[8] C. S. Pichamuthu, *op. cit.*, pp. 265, 273-274.
[9] P. Sampat Iyengar, *op. cit*, pp. 107, 115.
[10] *Ibid.*, p. 111.
[11] C. S. Pichamuthu, *op. cit.*, pp. 262-63. Figs. 2 and 3.
[12] C. S. Pichamuthu, *op. cit.*, pp. 24, 37.
[13] A. Holmes, *Petrographic Methods and Calculations*, p. 437; also F. W. Clarke "Data of Geochemistry," *U.S.G.S. Bull.* 695, pp. 27-28.
[14] C. S. Pichamuthu, *op. cit.*, pp. 6, 17.
[15] *Ibid.*, p. 31.
[16] *Ibid.*, p. 9.
[17] *Ibid.*, p. 16.
[18] B. Jayaram, *Rec. Mys. Geol. Dept.*, XX, Pt. 2, p. 40.
[19] C. S. Pichamuthu and M. R. Srinivasa Rao, *Curr. Sci.*, 1933, **1**, 276-277.
[20] C. S. Pichamuthu, *op. cit.*, p. 24; also *Curr. Sci.*, 1935, **3**, 606-608.
[21] *Ibid.*, p. 11.

I HAVE read through the remarks offered by Mr. M. B. Ramachandra Rao on the results of my work on some of the rocks of the Shimoga Schist Belt, and I am afraid that many of these remarks are based on a rather superficial reading of my papers. It is after more than five years of field and laboratory investigation that I have come to the conclusion that the conglomerates, quartzites and banded ferruginous quartzites of this area are possibly sedimentary in origin, and I do not think that I can reasonably be accused of either basing my observations on "insufficient examination" or being "hasty" in my conclusions.

I am perfectly aware that " many of the features such as the shape and rounding of the pebbles, sharp boundary between pebble and matrix, varied assemblage of pebbles, the difference between pebbles and matrix, and alternation of pebbly and non-pebbly bands, etc., are not entirely wanting in conglomerates which could be shown to be of autoclastic origin." But it is the cumulative effect of all these and other characters found in one particular bed, that I consider more important. I am not as sure as Rao, however, that a varied assemblage of pebbles can be present in an autoclastic conglomerate; certainly not, at any rate, the great variety that I have noticed and described in the Kaldurga conglomerates.[1]

Further, he states "Pichamuthu's argument that the granite pebbles do not contain orthoclase or microcline.... appears to be based on insufficient examination." Rao is obviously not aware that by the courtesy of the Director of the Mysore Geological Department, I had an opportunity of examining not only the particular slides he refers to (Z_4/869, 866) but also several others, and I am sure I have found no microcline or orthoclase. There is, no doubt, a little muscovite in the granite pebbles, but not enough to suggest that all the original potash-felspars were converted into this mineral.

I am particularly pleased to read from Rao's remarks that evidences of sedimentary origin of some of the rocks of the Shimoga Schist Belt have recently been obtained by B. Rama Rao. These discoveries strengthen my contention that some of these rocks have had a sedimentary origin. I would like to point out, however, that it is not quite fair to characterise my views arrived at after a detailed study of the various aspects of these rocks as " hasty " or " unwarranted " while according to Rao, ripple marks, current bedding and even "rain prints" recorded by Rama Rao in these metamorphosed rocks are " undoubted evidences of sedimentation " !

With reference to the tectonics of the area, the V-shaped outcrops of beds surrounding Nandi village,[2] indicate a pitching fold. Rao criticises me for "assuming" an overfold here, but himself proceeds to *assume* that the structure might have been caused by the intrusion of the granite.

Regarding the banded ferruginous quartzites, the great dominance of magnesia over lime has been considered both in the Lake Superior Region[3] and in Singhbhum[4] as evidence of sedimentation and in support of my conclusions, I have only followed this line of argument and have drawn attention to the similar relationships existing in the Bababudans.

In regard to the occurrence of spilitic rocks, it will be seen from a paper of mine to be shortly published elsewhere, that there is in this area, a soda-rich series of rocks

comprising albite granites, albite syenites, keratophyres, soda felsites, oligoclase dolerites, albite basalts, albitites and albite schists, and that the distribution of these rocks is not quite so "local" as Rao seems to think. Is it far-fetched to suggest that sediments derived from such a terraine would be rich in soda?

Rao would have it that metamorphism has been the cause of banding exhibited by the ferruginous quartzites. In *support* of this he quotes me and says "Pichamuthu himself notes as one of the effects of igneous intrusion 'the banding of the rocks have been emphasised and the ironstones in the neighbourhood recrystallised'." Rao has missed the significance of the word "emphasised" used by me; it obviously implies that the bandings were there before they were metamorphosed and that they were subsequently enhanced by metamorphism.

To any one who has not read my papers, Rao's statement, "that bababudanite is of secondary origin and not an original constituent of the amphibolites was pointed out by Jayaram as far back as 1923," might convey the impression that I was not aware of this. I have referred in one of my papers[5] to Jayaram's views who considered "that the occurrence of this mineral is precisely comparable to that of tourmaline in the altered acidic rocks of the Champion gneiss series". The other officers of the Mysore Geological Department did not, however, share with Jayaram in this view. My colleague, M. R. Srinivasa Rao, and I were the first to point out that the mineral was developed as a result of thermal metamorphism.[6] I am frankly surprised at Rao suggesting that I have now changed my views regarding the origin of this mineral in the schists. I have done no such thing. That I still adhere to the view that bababudanite has always originated due to contact metamorphism, becomes clear on page 30 of my paper on "The Iron Formations and Associated Rocks of the Eastern Bababudans" where I say "they (the bababudanite-magnetite schists) are formed by the thermal metamorphism of certain of the original layers in the ironstones"; also on page 37, where I have said, "like the mineral bababudanite, these amphibole magnetite schists have also originated as the result of contact metamorphism".

With reference to the age relationship between the Tarikere and the Bababudan Series, I have nowhere suggested that the Kaldurga conglomerate is a basal formation. When I say that "The Tarikere Series is younger than the Bababudan Series, not because of its intrusive character, but considering the stratigraphical sequence," I do not imply a stratigraphic break between the two Series. All that I mean is that the rocks belonging to the so-called Tarikere Series (mainly the conglomerates) overlie those which are supposed to belong to the Bababudan Series (the iron formation, etc.).

CHARLES S. PICHAMUTHU.

Central College,
Bangalore,
December 13, 1935.

[1] C. S. Pichamuthu, *Proc. Ind. Acad. Sci.*, 1935, **2B**, 265–268.

[2] *Ibid.*, p. 262.

[3] Van Hise and Leith, *U. S. Geol. Surv. Mon.*, 1911, **52**, 506.

[4] Percival, *Trans. Min. Geol. Inst. India*, 1931, **26**, 200.

[5] C. S. Pichamuthu, *Curr. Sci.*, 1935, **3**, 608.

[6] C. S. Pichamuthu and M. R. Srinivasa Rao, *Curr. Sci.*, 1933, **1**, 276–77.

Pungency in Chillies (*Capsicum annuum*): A Mendelian Character.

IN a letter to *Current Science*[1] under the above title, K. Ramiah and M. R. Pillai state as follows:—

> "The inheritance of a large number of characters in chillies has been studied by Deshpande (1933) but we have not come across any reference to the inheritance of pungency. It has therefore been considered that information given below with regard to this character will be of interest."

The inheritance of pungency has been studied by me and the results were reported in the *Scientific Reports*, Imperial Institute of Agricultural Research, Pusa, 1930–31, p. 37 and published in the *Indian Journal of Agricultural Science*, Vol. V, No. IV, Aug. 1935, 513–16. Both the references have evidently been overlooked by the authors. Their results, however, agree with mine in so far as the F_1 and F_2 generations are concerned.

R. B. DESHPANDE.

Botanical Section,
Imperial Institute of Agricultural
Research, Pusa,
November 25, 1935.

[1] *Curr. Sci.*, 1935, **4**, 236.

Moisture Variation Indices of Soils in Relation to their other Physical Properties.*

By M. S. Katti, B.Sc.

(*Research Student, Meteorological Office, Poona.*)

IN two recent papers[1,2] it was shown that during the clear season when the surface soil contains only hygroscopic moisture, there is a regular diurnal exchange of moisture between the soil and the air. Later,[3] it was observed that this variation of moisture content in the soil is a definite characteristic or "index" of that soil. It is interesting to study the "moisture-variation-index" in relation to other important physical properties of the soil (see Fig.).

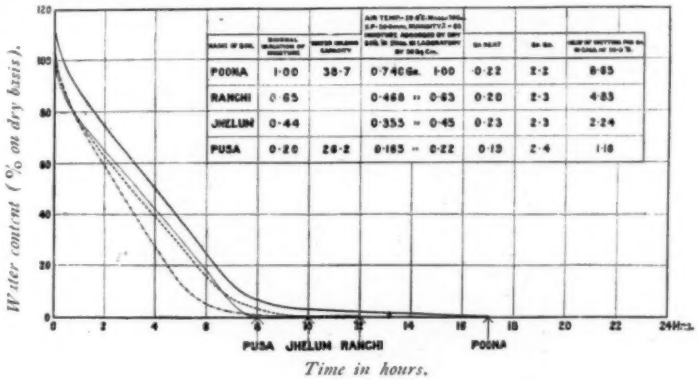
The sequence of the moisture variation indices of different soils as observed in the open is practically the same as that of their power to absorb water vapour when exposed under known conditions of temperature and humidity in the laboratory. The water-holding capacities of a few soils (expressed on air-dry basis) are given below :—

Soil			Water-holding capacity
Poona	..	..	38·7 %
Sholapur	..	..	40·9 ,,
Hagari	..	..	30·9 ,,
Bangalore	..	..	24·0 ,,
Pusa	..	..	26·2 ,,
Lyallpur	..	..	22·8 ,,

The black cotton group of soils is able to retain 15% more of water than the alluvial group.

The values of the heat of wetting at 25·9° C. for different soils run parallel to those of moisture-variation-index, being large for the black cotton soils and small for the alluvial soils.

In determining the moisture content of a soil, the sample is usually kept in the steam oven "till the weight becomes constant". An exact study of the rate of drying in a steam oven is very instructive. The weight-time curves (see Fig.) for four typical soils starting with about 100% water (on dry basis) not only show the time for complete drying but also the rate of drying at different moisture contents. The times taken by different soils for attaining a steady minimum weight at 100° C. are in the same order as their moisture-variation-indices.



POONA	1·00	38·7	0·740Gm. 1·00	0·22	2·1	8·65
RANCHI	0·65		0·468 " 0·63	0·20	2·3	4·83
JHELUM	0·44		0·355 " 0·45	0·23	2·3	2·24
PUSA	0·20	26·2	0·165 " 0·22	0·13	2·4	1·16

The similarity in the behaviour of a number of physical properties of different soils to their moisture-variation-indices is striking.

The above work was done under the guidance of Dr. L. A. Ramdas, Agricultural Meteorologist, Poona.

* Presented at the Colloquium, Meteorological Office, Poona, on 26-11-1935.

[1] Ramdas, L. A., and Katti, M. S., *Indian J. Agric. Sci.*, 1934, **4**, 923-37.

[2] Ramdas, L. A., and Katti, M. S., *Curr. Sci.*, 1934, **3**, 24-25.

[3] Ramdas L. A., and Katti, M. S., *Curr. Sci.*, 1935, **3**, 612-13.

Obituary.

Henry Fairfield Osborn (1857-1935).

THE sad death of Henry Fairfield Osborn, Zoologist, Palæontologist, Educationist, Author and Administrator, at the age of 78, has created a gap among the American men of Science which it would be hard to fill. President Osborn—as he was generally known in America since he became the President of the Board of Trustees of the American Museum of Natural History in 1908 after the death of President Jesup—made very valuable contributions to the sciences of Zoology, Palæontology and Biology; a great deal of his Zoological and Palæontological work was essentially biological, in that it contributed to an understanding of the nature, continuance and evolution of life. In addition, his services to the cause of Education and his work as an administrator and author, are so remarkable that any of them would have won him an outstanding place amongst the leading workers of the times. Osborn was born on the 8th of August 1857. His father, William Henry Osborn, was a Founder and for many years President of the Illinois Central Railroad, and from him apparently young Osborn inherited his great administrative talents. He was educated in the Columbia Grammar School and Lyons Collegiate Institute of the New York City, and later graduated at Princeton College where he was strongly influenced by the teachings of the well-known Geologist Professor Arnold Guyot. Taking up practical field work in the Museum of Geology and Archæology at Princeton soon after his graduation, he became the leader of the palæontological section of the University Expeditions to Colorado and Wyoming in 1877 and 1878. In 1878–79 he took courses in Anatomy and Histology at the College of Physicians and Surgeons in New York, and in 1879–80 went to Europe, where he studied Embryology at Cambridge under Professor Francis Balfour and Comparative Anatomy in London under Professor Thomas Henry Huxley. He later spent some time at Coburg, Germany, learning German. In 1881 he was appointed as the Assistant Professor of Natural Science at Princeton, and in 1883 as the Professor of Comparative Anatomy; this latter post he held till 1890. In 1891 he was invited to occupy the De Costa Chair of Biology of the Columbia University for organising the Zoological Department of the University. He selected the first officers of the department and was responsible for the planning of the teaching and research work in Zoology in this institution. During this period he started the well-known Columbia Biological series of publications and was also responsible for the starting of a University Press at Columbia which has done such useful work in the cause of education. From 1892–95 he served as the Dean of the Faculty of Pure Science of the University. In 1910 he retired from active teaching at Columbia, but up to his death retained his connection with the University as the Research Professor of Zoology.

Henry Fairfield Osborn.

From 1891–1910 Professor Osborn, in addition, carried on active work as the Curator of the Department of Vertebrate Palæontology at the American Museum of Natural History. In 1910 he retired from the Curatorship of this section, but he continued to act as the Curator-in-chief not only of this division but also of the divisions of Mineralogy, Geology, Geography and Astronomy. In addition to being a trustee

of the American Museum of Natural History, he served as its Vice-President (1899–1901) and was its President from 1908 to the date of his death. During his Presidential administration he inaugurated a highly efficient plan for the internal organisation of the American Museum, and established its well-known series of publications of which the *Natural History* is a popular publication well known all over the world. During the period of his administration there has been a remarkable advance in the palæontological technique of the Museum, while the most important development for the instruction and recreation of the visiting non-scientific public has been the preparation and installation of attractive museum groups in replicas of their natural surroundings in almost all sections of the Museum. As a result of his incessant propaganda work he was able to raise sufficient funds for sending numerous expeditions in search of fossil vertebrates and for the collection of natural history material not only to different parts of America but almost all over the world. It was his far-seeing policy that has made the American Museum of Natural History one of the biggest institutions of its kind, with its very rich study collections for research, and the beautiful and instructive exhibits in its very extensive public show galleries. Such galleries as the Hall of Life of the Oceans, the African Hall of Mammals, the Asiatic Hall of Mammals, the wonderful groups of birds from different parts of the American continent, the marvellous restorations of fossil animals from different parts of the world, the groups illustrating the life and habits of the American Indians from different parts of the American continents contain beautifully arranged exhibits of high educative value. His work in the cause of public education was considered of so great an importance as to be acknowledged by the award of the Roosevelt Medal of Honour, presented by President Harding in 1923.

In 1900 President Osborn was appointed as the Vertebrate Palæontologist of the U.S. Geological Survey, and in 1924 he was promoted to the rank of its Senior Geologist. In 1903 he was unanimously elected as the Secretary of the Smithsonian Institution, the highest scientific post in the United States of America, but in view of his great interest in the American Museum of Natural History he declined this high honour.

His first scientific contribution was published at the age of 21, and since that date during the 58 years of his active life he published an enormous number of original contributions either in the form of papers and monographs or as separate volumes dealing with special subjects. Of these, special mention may be made of his outstanding monograph on *The Titanotheres of Ancient Wyoming, Dakota, and Nebraska* (1929), his monograph on the *Fossil Proboscidæ* (1932), *From the Greeks to Darwin* (1894), *The Age of Mammals* (1911), *Origin and Evolution of Life* (1917) and *Men of the Old Stone Age, their Environment, Life and Art* (1918).

His earlier work was devoted to studies on the evolution of mammalian teeth, as a result of which he prepared a descriptive nomenclature which has replaced the conflicting and confusing terminology of previous investigators and resulted in his theory of "determinate variations" in the evolution of organisms, which he called the "doctrine of rectigradation": this is not to be confused either with the "orthogenesis" of Eimer, or with the "mutations" of de Vries. The same principle of hereditary ancestral control of variations he afterwards found illustrated by the origin and evolution of horns and other organs of vertebrates. His principles of adaptation were "neither theories nor hypotheses but facts clearly and repeatedly revealed by palæontological research," and these, according to Osborn, help to solve the riddle of the bio-mechanical origin of species. As a result of his detailed studies of the causes of evolution he enunciated his new principle of "tetraplasy" which he believed to be fundamental for the evolution of organisms. This principle of tetraplasy or "the law of the four inseparable factors of evolution" (1912) was formulated as follows: "The life and evolution of organisms continuously centre round the processes which we term heredity, ontogeny, environment and selection. These have been inseparable and interacting from the beginning. A change introduced or initiated through any one of these factors causes a change in all."

Amongst his Zoological contributions, reference may be made to his papers dealing with the "Brain of Amphiuma," the "Brain of Menopoma" and the "Internal Structure of the Amphibian Brain" (1883–1888). This work resulted in his detailed "Studies on the Brains of Amphibians, Reptiles and Birds" and led to the establishment of an

American School of Neurological Research by his students, of whom Strong and Herick deserve special mention. As he himself stated, the new biological principles which he enunciated as a result of an inductive line of investigation, have not been universally accepted, but the environmental principles of adaptive radiation, polyphyletic evolution and homogenic classification have gained wide support amongst Palæontologists and, to some extent, among Zoologists.

President Osborn was a member of a large number of scientific academies and societies, and was also the recipient of a large number of medals and awards both in the United States and of the leading scientific societies all over the world. He was a foreign member of the Royal Society of London and was the only Zoologist to be elected as an Honorary Centenary Member of the Asiatic Society of Bengal in 1934. The writer had the privilege of meeting him first in 1925 on the occasion of the Meeting of the British Association for the Advancement of Science in Oxford and later in New York in 1930, and can never forget the impression created by his masterful personality. President Osborn was a charming man, pleasant and unassuming to talk to, and his interest in anything relating to Science and Education was all-absorbing. May his soul rest in peace!

B. P.

[*Note.*—The writer of this notice acknowledges his indebtedness to Osborn's *Fifty-two Years of Research* (1930) for details in reference to his life.]

The Snakes of India: A Historical Review.*

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INTRODUCTION.

THE recent publication of Gharpurey's book[1] on the Snakes of India affords a suitable occasion to present a historical review of the main works[2] on Indian Ophiology published so far. Such a review, it is hoped, would not only help interested readers to select what they want in this line, but would also probably suggest to prospective authors the scope for new ventures. Smith's volume on the Indian Ophidia[3] is now in course of preparation, and the present review has thus the further advantage of preceding a work, which is expected to give a fresh stimulus to the study of this fascinating group of animals.

The history of Indian Ophiology falls naturally into four main periods: First, the *Pre-Scientific Period*, which extended from times immemorial to somewhere towards the end of the 18th century and comprised numerous scattered observations on Snakes (partly correct, but mostly erroneous) in the Hindu religious books and traditions; secondly, the *Initial Scientific Period*, which dawned with the interest in Ophiology of some early English officials in India and is mainly represented to us in the works of Patrick Russell; thirdly, the *Pre-Modern Period*, which was ushered in by Günther (1864) and extended up to the publication of Boulenger's *Reptilia and Batrachia* (1890); and lastly, the *Modern Period*, which extends from 1890 to date.

All these four periods overlap to some extent, and the division cannot, therefore, be regarded as a rigid one. For the purpose of the present review, however, we find it most convenient and we hope that further work would only bear it out.

PRE-SCIENTIFIC PERIOD.

As far as we are aware, there is no ancient Indian book dealing exclusively with Ophiology, but scattered here and there one often comes across a great many notions and allusions about Ophidians in the Hindu scriptures. One of the Vedas[4] has several verses about them, and both *Mahábhárata* and *Bhavishya-purána* have much in them that is interesting in this connection. Perhaps here one might draw attention to Shripád-Dámodar Sátavalekar's "वैदिक सर्प विद्या" and to Jayadeva Sharma's articles in *Vijnána*,[5] as also to Fayrer's address[6] to the Victoria Institute, to Fergusson's *Tree and Serpent-Worship*, and to Tylor's *Primitive Culture*.

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* The reviewer lays no claim to omniscience of the books published on Indian Ophiology. For the last nine years he has been interested in the subject and is acquainted with the more important literature. While he feels that he has not missed any important book on the subject he would be glad to know from readers whether any important publication has been omitted from the review.

[1] Gharpurey, K. G., *The Snakes of India*. Popular Book Depot, Grant Road, Bombay, 1935.

[2] With the exception of three series by Major Wall, which were published in the *Journal of the Bombay Natural History Society*, and which are, to all intents and purposes, books in their scope though not in their get-up and form, the present review is confined only to a survey of books and does not take notice of the numerous articles—taxonomic and otherwise—which appeared from time to time on Indian Ophiology in various scientific journals.

[3] Smith, Malcolm A., "*Reptilia and Amphibia*" (*Fauna of British India*), Vol. III (in course of preparation).

[4] *i.e.*, Atharvaveda.

[5] Jayadeva Sharma, "प्राचीन सर्पजन विद्या", *Vijnana*, **18**, pp. 8-12 and 74-79; "वेदमें सर्प विद्या", *Vijnana*, **18**, pp. 108-112.

[6] Fayrer, Joseph, *On Serpent-worship and on the Venomous Snakes of India*.

Initial Scientific Period.

This period is principally represented to us by two volumes, which are probably the first scientific approach to Indian Ophiology in the form of a book publication. The first volume of Russell's *Account of Indian Serpents, collected on the Coast of Coromandel*[7] was published in 1796, and the second in 1801–1809. Both these volumes contained brief descriptions and "carefully executed plates" of various Indian snakes, but it must be pointed out that Russell "applied only the vernacular names to his specimens,"[8] which is rather unfortunate as vernacular names are in most cases variable and have only a local application, especially in a country like India where the language of the people differs so much from place to place. As Malcolm A. Smith[9] points out, "native names are often unreliable, except for the commonest forms. The same species may have a different name in a different part of the country, even though the language has not changed, or the same name may be applied to two different species. After all, it is not to be wondered at, for the country people have no great interest in reptiles except for the few that enter into their dietary."[10]

Patrick Russell, however, "was the pioneer of Indian Ophiology. He was the first person in India to distinguish the harmless from the venomous snakes, which he did by a careful examination of their teeth; he made also many experiments with animals to discover the toxicity of their poison..... A number of his preserved snakes and his collection of dried skins, some of which are the specimens from which his drawings were executed, are now in the British Museum (Natural History). The dried skins are carefully mounted on strong paper, and many of them still show the living colours remarkably well. He died in London. A good account of his life, with a portrait will be found in the second volume of his *Indian Serpents*, which he did not live to complete."[11]

Pre-Modern Period.

In 1864, a general work by Dr. A. Günther appeared on *The Reptiles of British India*,[12] and it contained descriptions of 180 species of Indian Snakes, along with those of other Reptiles. The work was "founded on the earlier publications of Russell, Cantor, Gray, Blyth, Jerdon, Kelaart, and others, largely supplemented by the author's own researches;"[13] but its main contribution to Indian Ophiology lay in proposing a new classification which was readily accepted by many subsequent workers (sometimes, with alterations) and lasted till the publication of Boulenger's volume in 1890.

As pointed out by Malcolm A. Smith, "the term India at that time was used in a much wider sense than it is to-day,"[14] and the area included by Günther practically comprised all the South-eastern Continental Asia. Amongst the earlier workers on Indian Herpetology, Günther occupies a premier position, and it is with some regret that one notes the omission of an account of his life from the short, excellent biographical sketches of the "best-known Indian and Indo-Chinese herpetologists" that Malcolm Smith gives us in the Introduction[15] to the First Volume of his *Reptilia and Batrachia*.

Eight years after the publication of Günther's Monograph, Fayrer (1872) made an extremely valuable contribution to Indian Ophiology in the form of a large-sized volume entitled *The Thanatophidia of India*[16] and published by J. and A. Churchill, London. The volume opened with four quotations from Shakespeare, was dedicated to the Right Hon. the Earl of Mayo, Viceroy and Governor-General of India, and contained 31 large plates, all but three of which were beautifully coloured and represented artistically the natural appearance of Indian venomous snakes. The last three (uncoloured) plates showed the method of handling a snake, the muscular apparatus for erecting fangs, the poison glands, the head shields of a colubrin snake, diagrams of fangs, skull, etc.

Fayrer's aim was to make "reliable information on the Venomous Snakes of India" generally available and he modestly claimed that in his book "there is no pretension to novelty in the description of the snakes." He chiefly based his classifications and definitions on Günther, or on other authors of repute, and the anatomical descriptions on those of Owen and Huxley, but he had "carefully verified their descriptions by comparison with, and by careful dissections of the snakes themselves". Most of what he writes is authoritative, and probably that is due to a "close observation of the principal Indian forms of poisonous snakes during life, for a period of more than three years". His main interest lay in the physiological action of snake venoms, and he performed 29 excellent series of scientific experiments *on the influence of snake poison on the lower animals, and on the value of certain modes of treatment and reputed antidotes*,[17] which have not so far been surpassed.

To say that Fayrer was an influential man is putting the matter too mildly. He was Honorary Physician to the Queen, Surgeon-Major, H. M. Bengal Army, Professor of Surgery and Senior Surgeon in the Calcutta Medical College and its Hospital, Fellow of the University of Calcutta, a President of the Asiatic Society of Bengal, F.R.S., F.R.S.E., and C.S.I. His position gave him many facilities in the way of Ophiological research that are denied to lesser men,

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[7] Russell, P., *An Account of Indian Serpents, collected on the Coast of Coromandel*. 2 Vols. London, 1796-1801 (known to the reviewer through Malcolm A. Smith's description).

[8] Smith, Malcolm A., *Fauna of British India, Reptilia and Amphibia*, 1931, **1**. 3.

[9] *Op. cit.*, pp. 1–2.

[10] The reasoning is not very plausible. The country people of India are interested, for instance, in the Cobra, the Uromastix, the sacred Turtle of Jamuna, but none of these animals forms part of their dietary.

[11] Smith, Malcolm A., *op. cit.*, p. 3.

[12] Günther, A., *The Reptiles of British India*, pp. 444, 26 pls., London (known to the reviewer through Boulenger's description).

[13] Boulenger, G. A., *Fauna of British India, Reptilia and Batrachia*, 1890, London, p. iv.

[14] Smith, Malcolm A., *op. cit.*, p. 2.

[15] Smith, Malcolm A., *op. cit.*, pp. 3-13.

[16] Fayrer, J., *The Thanatophidia of India, being a description of the Venomous Snakes of the Indian Peninsula, with an Account of the Influence of their Poison on Life and a series of experiments*, J. & A. Churchill, London, 1872.

[17] Fayrer, J., *op. cit.*, Section V, pp. 63-145.

and he was not a person to forego opportunities. By having an official circular sent round by the Inspector-General to Deputy-Inspectors-General of Hospitals, he collected an imposing array of cases of snake-bites with valuable data.[18] He addressed letters to the Secretaries or Political Agents of Bengal, North-West Provinces, Punjab, Oudh, Central Provinces, Central India, Rajputana, and British Burmah, and collected statistics about deaths from snake-bites, which are really imposing.[19] After a careful study of all the methods of treatment of snake-bite available in his days, he gave in his book an excellent account of the subject, together with "suggestions for the immediate treatment of persons bitten by venomous snakes".[20] *The Thanatophidia* ends with 8 appendices, the third of which contains an account of the use of snake-venom in Ayurveda (*i.e.*, "by the Kabirajes of Bengal"), and the fourth with the four classes of snake-charmers found in Bengal.

Besides this monumental work, Fayrer was a frequent contributor to the *Proceedings of the Royal Society* on matters pertaining to Indian Ophiology, and it is interesting to note that he, in collaboration with Brunton, was the first to discover the antidotal power of permanganate of potash and chloride of gold in cases of snake-bites.[21] Some of his papers, originally published in 1873–1904, were collected together by Brunton and reprinted in the form of a book[22] in 1909.

Fayrer's *Thanatophidia*, though a first-rate contribution to Indian Ophiology, is unfortunately large, unwieldy and expensive, and thus it was felt necessary to issue a shorter work which might be treated as a hand-book by "the busy officials of India" for the recognition of any of the poisonous snakes of this region. This was the occasion for a smaller volume by Ewart,[23] which contained 21 coloured plates of snakes borrowed from Fayrer, a short introductory chapter on "Symptoms and Treatment of Snake-Poisoning," concise accounts of the more important venomous snakes and a glossary at the end to help the layman to a meaning of the words used.

In 1874, Nicholson published a small book on *Indian Snakes*,[24] which—though not so imposing as Fayrer's work—is full of valuable information and original observations. Nicholson was a keen student of Indian Ophiology and loved to study the snakes and their ways as much in their natural surroundings as in a museum. He started to give the readers a hand-book of Indian Snakes, and he succeeded in producing a volume which is certainly true to the sub-title *An Elementary Treatise on Ophiology*. Beginning with a short introduction assigning the proper place to Ophidia in the scheme of scientific classification, he proceeds to deal in the First Part of his book, with the anatomy of this group of animals. The skeleton, the mouth and teeth of harmless and venomous snakes, the internal organs, the senses and the integument are all treated concisely though clearly, much of the material probably having been derived from Owen and Schlegel. In the Second Part of his book, he classifies the Indian Ophidia, gives a Phylogenetic Tree based on his own studies, and describes the Indian forms carefully. The Third Part deals with the natural history of snakes and does much credit to Nicholson's interest in Indian Ophiology. His chapters on "The Snake at Liberty," "The Serpentarium," "Schemes of Extermination," and "Snake Mythology" are full of original matter, and some of them, at any rate, must have necessitated much thought and patient observation. It appears that not satisfied merely with the study of preserved specimens, Nicholson used to keep live snakes with him and to observe them carefully, besides going out snake-hunting off and on. In the chapter on "Museum" he gives valuable information for the preservation of specimens and other allied matters, and in that on "Snake-Poison and Antidotes" he adds some information of his own to a survey of what was already known on this subject.

One feels tempted to make an interesting quotation from Nicholson, partly because it forms really good advice and partly also because it gives us a clue to the mentality of this author. He says,[25] "From the eagerness of people to look for the marvellous in all that concerns snakes, the observations of non-scientific enquirers are always open to suspicion. On this subject, the safest plan is to believe nothing that you hear, and only half what you see yourself, guarding carefully against the liability of your visual impressions being influenced by your expectations and pre-conceived ideas."

Two years after the publication of Nicholson's work and twelve years after that of Günther's, another general work[26] on the Reptiles of British India appeared with the object of meeting "a want which.....blocks the way to the general study of Herpetology in India, and to supply in an accessible and portable form such a condensed description of our Indian Reptiles as may enable any one interested in the Fauna of his locality to acquaint himself with the Reptiles he meets with." Theobald's *Descriptive Catalogue of the Reptiles of British India* was based on Günther's work, but it excluded 'Hydrophidæ' and the 'Batrachia' from its scope, and restricted itself to British India alone. To a great extent, it was "virtually an abridgment of Günther's, but with the numerous discoveries and observations of Stoliczka, Beddome, Anderson, and of the author himself added to those of Günther,

[18] Fayrer, J., *op. cit.*, Section IV, pp. 42-62.

[19] Fayrer, J., *op. cit.*, Section II, pp. 30-36.

[20] Fayrer, J., *op. cit.*, Section III, pp. 37-41.

[21] Brunton, T. Lauder and Joseph Fayrer, "*Note on the Effect of Various Substances in Destroying the Activity of Cobra-Poison*" (*Proc. Roy. Soc.*, 1878, **27**, 465); "*Experiments on a Method of Preventing Death from Snake Bite, capable of Common and Easy Practical Application*" *Proc. Roy. Soc.* 1904, **73**.

[22] "*On the Poison of Venomous Snakes and the Methods of Preventing Death from their Bite.*" (Reprinted Papers by Joseph Fayrer, Lauder Brunton, and Leonard Rogers.) Macmillan, London, 1909.

[23] Ewart, *Poisonous Snakes of India*. (Year and place of publication not known.)

[24] Nicholson, Edward, *Indian Snakes: An Elementary Treatise on Ophiology*. Higginbotham & Co., Madras, 1874 (Second Edition).

[25] Nicholson, Edward, *op. cit.*, p. 125.

[26] Theobald, William, *Descriptive Catalogue of the Reptiles of British India*, Thacker, Spink & Co., Calcutta, 1876.

many additions by the latter having been made after the publication of his large work on Indian Reptiles."[27] It contained descriptions of 225 species of Ophidians, while Günther's Monograph —in spite of the larger geographical region that it dealt with—had described only 180 species.

Theobald's book is deficient in illustrations, there being only two on page iii of the Appendix, and his descriptions do not aim to be exhaustive, but include, as he says, "only so much detail .....as will enable the student to specifically determine" any species. Following 4 pages of "Errata et Addenda," the text concerns itself with systematic descriptions of the orders, families, genera and species of various reptiles, 126 pages being devoted to the order Ophidia. A list of non-Indian species included in Günther's Monograph is given, as also an Index of the Genera and species of Indian Reptiles and a Key for their identification. The book ends with an Appendix dealing with "the means of discriminating between poisonous and harmless snakes and the treatment of snake-bite."

Much work has been done on Indian Ophiology after Theobald, and thanks to the labours of Major Wall, we have now a better key for the distinction of venomous[28] from non-venomous snakes. Still, however, the following advice by Theobald bears reiteration: "Perhaps, the simplest way of learning what are poisonous snakes, would be to pass an hour or so in some museum where acquaintance might be made with the commoner or more deadly species."[29] After all, both Boulenger's[30] method of the examination of dentition and Colonel Wall's of scrutinising the scales are applicable only to dead specimens and fail when the snake is fully alive and vigorous. Then it is *only* Theobald's advice which might be of some use. We have to know the poisonous snakes individually in order to be able to pronounce judgment on live ones.

MODERN PERIOD.

The modern period in Indian Ophiological research begins with the publication of Boulenger's volume on *Reptilia and Batrachia*[31] in 1890. Boulenger was already famous for the laborious Catalogues[32] of the Reptiles in the British Museum that he had prepared, and he had made his mark as a first-rate herpetologist. His volume on Indian Reptiles and Amphibians was readily accepted as a standard work, and although a number of the species described by him have undergone changes in the light of further work, his book still forms the basis of taxonomy about these animals. He gave us a new classification for the Ophidia, a classification which is regarded by most Ophiologists as "a logically-conceived system, by far the best hitherto proposed,"[33] and which has been implicitly followed by later workers. The previous classification of the Ophidia was due to Günther, and consisted essentially in the division of this Order into 21 families, arranged into four suborders: *Hopoterodontes, Colubriformes, Colubriformes venenosi, Viperiformes.* Boulenger, however, recognised only 9 families and assigned the rank of sub-families to several previously called families. The section on Ophidia in his book contains descriptions of 264 species and occupies 200 pages.

Starting with an extremely short introduction about the Ophidia (pp. 232–33), mainly concerned with the characteristic peculiarities of the order and with remarks upon the distinction between poisonous and non-poisonous snakes, the poison-glands and fangs, he gives a Synopsis of the Families, followed by systematic descriptions. The section on Ophidia is illustrated with 59 carefully-drawn figures. As pointed out in the Preface, "the classification of the Snakes, which comprises nearly one half of the Reptilian species known to occur in India, is new, and all the descriptions of families, genera, and species have been prepared expressly for the present work. As there is no recent publication with a complete synonymy of the Ophidia, somewhat fuller references to the literature of the subject have been rendered necessary than in the other suborders of Reptiles and Batrachians."[34]

Boulenger's volume, apparently designed for the scientist, is written in such a compact and concise manner as not to be of much use for the layman. His descriptions of species and genera are models of compression, and he does not explain the terms that he uses. The lengths mentioned in the description of the species are apparently the maximum that he found, and he notes the habitat of each species that he records.

In 1891, Sclater published a *List of Snakes in the Indian Museum*,[35] a book containing x + 79 pages and giving no descriptions of any species at all, but only details about the place and date of collection, the name of the collector, etc., of the Ophidian specimens then in the Indian Museum. Under the name of each species is given the name of "the Author of the specific name and a reference to the best description, not necessarily the original one, to which" the author had "been able to get access". Sclater adds 14 more species to those described by Boulenger, and gives a list of those species of snakes which were not in the Indian Museum.

From 1895 to 1925, we find an indefatigable

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[27] Boulenger, G. A., *Fauna of British India* (*Reptilia and Batrachia*), 1890, p. iv.

[28] Owing to M. Phisalix and Caius's work, we now know that almost all snakes are poisonous—to their legitimate prey, and so the word 'venomous' or 'poisonous' is now understood to mean 'poisonous to man or higher animals'. (See Prater, S. H., "*Non-poisonous Snakes*" *in Jour. Bom. Nat. Hist. Soc.*, **1933, 36, 391-394.**

[29] Theobald, William, *op. cit.*, p. ii (Appendix).

[30] Boulenger, G. A., *Fauna of British India: Reptilia and Batrachia*, 1890, p. 233 (Boulenger, however, is not the discoverer, but an exponent of this method).

[31] Boulenger, G. A., *Fauna of British India: Reptilia and Batrachia*, London, (1890).

[32] Boulenger, G. A., *Catalogue of the Chelonians, Rynchocephalians, and Crocodiles in the British Museum* (*Natural History*), 1889. *Catalogue of the Lizards in the British Museum* (*Natural History*), Vols. I-III, 1885-7. *Catalogue of the Batrachia Gradientia s. Caudata and Batrachia Apoda in the Collection of the British Museum*, 2nd Edition, 1882. *Catalogue of the Batrachia Salientia s. Exaudata in the Collection of the British Museum* 2nd Edition, London, 1882.

[33] "*Snakes*", *Encyclopædia Britannica*, 1911, **25**, pp. 288 ff. (Hans Gadow).

[34] Boulenger, G. A., *Fauna of British India* (*Reptilia and Batrachia*), Preface by W. T. Blanford, p. iv.

[35] Sclater, W. L., *List of Snakes in the Indian Museum*, Calcutta, 1891.

worker in the person of Colonel Frank Wall in the cause of Indian Ophiology. "He collected in all parts of the Indian Empire, and by his energy and enthusiasm stimulated others to make collections for him. For many years he has been the chief authority on Indian snakes. He visited in turn every museum in India and overhauled their collections. He was a prolific writer, and managed to combine admirably the scientific and popular sides of the subject. He was a constant contributor to the *Journal of the Bombay Natural History Society*, but wrote also for other Indian journals. The types of the numerous snakes described by him, together with many other specimens, are in the British Museum (Natural History); the rest of his collections are in the museums in India, principally in Bombay."[36]

It is beyond the scope of the present review to make a survey of even the more important contributions of Colonel Wall to Indian Ophiology, but we have selected three series of his, published in the *Journal of Bombay Natural History Society*, for inclusion here.

A Popular Treatise on the Common Indian Snakes[37] was published from 1905–1914, and ran into as many as 23 parts. It was copiously illustrated both with coloured plates and diagrammatic figures throughout, and must have necessitated patient research and close observation on Indian snakes for many years. Unfortunately the Bombay Natural History Society has not so far published it as a separate book, in spite of the fact that there is a general demand for such work.

The series begins with the intention of acquainting the readers with the common snakes of India and it fulfils its purpose remarkably. As the author himself says, "there is no book on the subject written in popular language, and the few that show coloured plates are very expensive, while accuracy of detail seems to have been largely sacrificed for pictorial effect.... The descriptive parts of the best works are couched in terse and scientific language, and though excellently written by experts in museums the authors have had no facilities for observing the habits of creatures they only see in spirit on museum shelves. We must, therefore, rely upon those who actually come into contact with living snakes to supply such information."[38] Wall's series supplies such information to a very great extent.

The whole series is excellently written to evoke popular interest and within its scope, has not been surpassed up to the present time. Wall takes one species after another, and like an adept scientific snake-charmer, gives particulars about nomenclature (scientific, English and Vernacular), dimensions, bodily configuration, colour, identification, haunts, disposition, food, breeding habits, and what not. One often wonders at the amount of knowledge he has garnered, and admires his clear mode of expression.

In 1906, appeared a much shorter series by Wall: *The Poisonous Snakes of India and How to recognise them*;[39] and this series was later published in the form of a book[40] in 1908, with many alterations and changes. The book is an authoritative contribution to the subject and so far as we know, has already passed through 4 editions. Wall prepared a key [41] for the identification of poisonous from non-poisonous snakes in 1902, and the fact that the key met with much favour and was even circulated by the Inspector-General of Civil Hospitals in the Central Provinces, seems to have encouraged him to write this series.

A third series[42] by Colonel Wall, entitled *A Hand-list of the Snakes of the Indian Empire*, was written for the field naturalist, and set out to enumerate all the species of Indian ophidians known at that time, besides giving such details as type, length, lepidosis, distribution, etc., in a concise manner. It serves as a good supplement to Boulenger's work, and makes the taxonomic work of later years accessible to the reader.

In 1914 was published a much less pretentious book by Cazaly,[43] only 60 octavo pages in extent and designed to help the layman to an identification of the commoner snakes of India. The book is written in extremely simple language, does not claim to add anything new in the form of facts, and relies for its information on Nicholson's *Indian Snakes* and Wall's *Poisonous Snakes*, and for names on Boulenger's *Catalogue of Snakes*.

In 1919, Roberts[44] made a curious collection of the details of the *remedies that are employed by the native physicians of Ceylon and India in the bites of snakes and other animals, and in the stings of animals*. Although we cannot support the use of these medicines as there is no scientific backing for them, we have been much interested in the book itself, and especially in the specimens of "magical spells"[45] given in it.

D'Abreu's *The Snakes of Nagpur* (1916),[46] Wall's *The Snakes of Ceylon* (1921),[47] and Prater's *The Snakes of Bombay Island and Salsette* (1926),[48] are all restricted in the geographical area that they deal with, but are good in their own spheres.

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[36] Smith, Malcolm A., *op. cit.*, **1**, pp. 12-13.

[37] Wall, Captain F., "*A Popular Treatise on the Common Indian Snakes.*" (*Jour. Bom. Nat. Hist. Soc.*, 1905, **16**, 533-554, (Part I); 1914, **23**, 206-215 (Final, *i.e.*, **23** pt.)

[38] *Jour. Bom. Nat. Hist. Soc.*, 1905, **16**, 533.

[39] Wall, Capt. F., "*The Poisonous Snakes of India and How to Recognise Them.*" (*Jour. Bomb. Nat. Hist. Soc.*, **17**, 51-71, 299-333).

[40] Wall, Col. F., "*The Poisonous Terrestrial Snakes of our British Indian Dominions (including Ceylon) and How to Recognise them with Symptoms of Snake Poisoning and Treatment*" [*Bomb Nat. Hist. Soc.*, Bombay, 1908 (1st ed.); 1917 (3rd ed.); 1928 (4th ed.)]

[41] Wall, Capt. F., "*The Distinguishing Characteristics between Poisonous and Non-Poisonous Snakes*" (*Jour. Bomb. Nat. Hist. Soc.*, 1902, **14**, 93-102.)

[42] Wall, F., "*A Hand-List of the Snakes of the Indian Empire*" [*Jour. Bomb. Nat. Hist. Soc.*, 1923-4, **29**, 345-361. (Part I); pp. 598-632 (Part II); pp. 864-878 (Part III); 1924-25, **30**, pp. 12-24 (Part IV); pp. 242-252 (Part V)].

[43] Cazaly, W. H., *The Common Snakes of India and Burma and How to Recognise Them.* Pioneer Press, Allahabad, 1914. This has only 11 figs.

[44] Roberts, Emmanuel, *Native Remedies used in Snake Bites, etc.*, H. W. Cave & Co., Colombo, 1919.

[45] Roberts, Emmanuel, *op. cit.*, p. ix.

[46] D'Abreu, E. A., *The Snakes of Nagpur*, Government Press, Nagpur, 1916.

[47] Wall, Col. F., *The Snakes of Ceylon*, 1921.

[48] Prater, S. H., "*The Snakes of Bombay Island and Salsette*" [*Bomb. Nat. Hist. Soc.*, 1926].

In 1923, Wall gave us an invaluable book on the *Identification of Indian Snakes*,[49] full of keys and synopses that have proved almost infallibly useful to the reviewer for the last 9 years and represents a laborious research on the part of the author for very many years. Wall says, "In my early days in India when I began to take up the study of snakes I found it extremely difficult to find out the names of the commonest specimens I encountered. The books on the subject then available gave little, if any, help to one like myself a beginner. The keys given to assist the student were very unsatisfactory, being too scientific. Often indeed one had to investigate difficult points which called for skilled dissection, points concerning peculiarities in the dentition, or even the more difficult matter relating to processes such as those of vertebræ. Very few men in India have the inclination or skill necessary to investigate such points, still fewer have leisure hours sufficient to undertake such a laborious and difficult task. In consequence many with a natural bent for biological research are deterred from taking up a subject which would provide endless interest, and pleasure, especially to men who are often alone in camp, on tea and coffee plantations, or who have joined the Indian Forest and other services."[50] For such people and others, even for workers in museums, Wall offers the fruits of his labours in this book, and we are sure that an identification arrived at by his methods, if confirmed later by a reference to Boulenger's work or some other standard volume, would be unimpeachable.

Wall's keys and synopses are based on a study (mostly statistical) of the scale characters of Indian ophidians, and as he himself points out, they have been assailed on the ground that they "are not natural ones, but what some reviewers of" his "past work term 'unscientific". The only drawback we find in them is, that they give no idea about Ophidian *genera*, and especially in the case of such a family as *Colubridæ*, not only bring together forms that are believed to be much apart from each other, but also separate allied species from one another. In some cases the same species (*e.g.*, *Coluber helena*, *Zamenis arenarius*, *Naia tripudians*, etc.) occupies two or more different positions in the same synopsis.[51] Besides, in a chart like that for the genus *Silybura*[52] or *Rhinophis*,[53] too much stress has apparently been laid on the relative proportions of the head shields and little allowance made for the play of individual variations that one is apt to find so often in nature.

In 1929, a rather large book appeared "from the pen of a layman," Paresh Banerji,[54] which was not really a contribution to Indian Ophiology, but a sort of advertising campaign by the writer in favour of a specific ("Lexin") that he claimed to have invented for snake poisoning. The book was, on the whole, well published and had several coloured plates of Indian snakes; but unfortunately, a greater part of it was devoted to substantiating the 'efficacy' of the 'supposed' snake specific, and it contained as many as 1134 reports of cases in which Lexin was said to have cured snake-bites.

This brings us to the latest book published on the subject: that by Gharpurey (1935), which is a popular contribution to Indian Ophiology, and is written with the object of enabling laymen to distinguish poisonous from harmless snakes and of giving information about the common forms met with in India. The author claims an interest "in the subject for over 25 years, being drawn to it mainly by the heavy mortality figures," and he has drawn largely for his materials on such standard books as those by Wall, Fayrer, Nicholson, etc. He modestly says, 'that there is hardly anything original in this book," but still he has made careful compilation of a huge amount of information about Indian snakes and he has presented his subject in a simple and lucid manner.

CONCLUSION.

In spite of much good work done on Indian Ophiology in the past, there is still a great deal of scope for further investigations in this subject, and it is hoped that more and more workers would take an active interest in it and add their contributions. True it is, that "systematic collecting has been carried out in nearly all parts of the Indian Empire, and, except in the more inaccessible mountain districts, the herpetological fauna of the country is now pretty well known."[55] But "in the exact distribution of the species, in their individual variation, in habits, life-histories, in fact in bionomics generally, a vast amount of investigation has still to be done," although "for the mere collector in search of new species no great field remains."[56]

[49] Wall, Colonel F., *How to Identify the Snakes of India* (*including Burma and Ceylon*), 1923.
[50] Wall, *op. cit.*, Preface.
[51] Wall, *op. cit.*, pp. 23 38.
[52] Wall, *op. cit.*, pp. 13-16.
[53] Wall, *op. cit.*, p. 17.
[54] Banerji, Paresh, *Hand-book of Snake-bite*, P. Banerji, Mihijam (India), 1929.
[55] Smith, Malcolm A., *Fauna of British India: Reptilia and Amphibia*, 1931, 1, 1.
[56] Smith, Malcolm A., *op. cit.*, p. 1.

Research Notes.

Theory of Meromorphic Functions.

LARS AHLFORS ("über erine Methode in der Theorie der Meromorphen funktionen," *Com. Phy.-Math.*, T. **8**, Nr. 10) has contributed a valuable paper on the introduction to the theory of meromorphic functions. After the fundamental contribution of Rolf Nevanlinna characterised by his first two fundamental theorems, the introduction was simplified in two directions. One was due to the Japanese workers headed by Shimuzu and the other was due to the Finnish school headed by Selberg and Frithiof Nevanlinna. Combining and crystallising all these methods the author has proved the chief properties of the characteristic function $T(r)$, and has deduced the second fundamental theorem of Nevanlinna in 14 pages. The ideas underlying the contribution are these :—First of all $m(r, a)$ is defined to be

$$\frac{1}{2\pi}\int_0^{2\pi} \log \frac{1}{\{f, a\}}\, d\theta$$

where $f(z)$ is the meromorphic function and (a, b) denotes the straight-line distance between the stereographic projections of a and b on a sphere of diameter unity touching the plane at the origin. (This is essentially the same as the earlier definition of Nevanlinna.) $N(r, a)$ is defined to be the same. Next by a simple differentiation and applying the principle of argument the independence of $T(r, a)$ w.r.t. a is deduced. There is no need to apply the Poisson-Jensen formula at all. Next taking $\rho(a)$ to be any positive function such that $\oint \rho(a)\, d\omega(a)$ taken over the surface of the sphere $= 1$, he has shown in a single step that if

$$m_\rho(r) = \oint m(r, a)\, \rho(a) d\omega(a) \text{ and } N_\rho(r) = \oint N(r, a)\, \rho(a) d\omega(a).$$

then $T(r) = m_\rho(r) + N_\rho(r)$ also. From this he has easily deduced the convexity of $T(r)$ w.r.t. $\log r$. This is extremely simple when we remember the fact that this is proved by Nevanlinna by making use of the properties of the Green's function corresponding to a ring-region. The second fundamental theorem of Nevanlinna is obtained as a corollary of this result by taking a suitable density function $\rho(a)$; *viz.*,

$$\text{Log } \rho(f) = c + 2\sum_1^q \text{Log } \frac{1}{\{f, a_v\}} - a \log \left[\sum_1^q \log \frac{1}{\{f, a_v\}} \right]$$

where c is a normalising constant and a is any number > 1. Some words are to be said with respect to the form of the theorem we obtain when we consider functions meromorphic in the unit circle. We get

$$\sum_1^q m(r, a_v) < 2T(r) - N_1(r) + \log T(r) + k' \log \frac{1}{1-r} + 0\,(1)$$

except in a set of intervals I_t such that $\Sigma \int_{I_t} \frac{dr}{(1-r)^{1+\epsilon}}$ is finite, k' being a constant which can be made as near to unity as we like. This is much sharper than the corresponding theorem by Nevanlinna and others and in fact as sharp as the result obtained by F. Nevanlinna by the use of suitable modular functions.

The second fundamental theorem mentioned here is not the *proper*—Nevanlinna by applying his *proper* second fundamental theorem in connection with his proof of Picard-Borel theorem. The proper theorem itself is applied by Nevanlinna to deduce further theorems, such as the theorems of unicity, etc. Probably these theorems can all be deduced directly by Ahlfors's method, but the proper theorem itself can be proved by Ahlfors's method as follows. Take

$$\rho(f) = k \frac{1}{\{f, \infty\}^2 \{f, 0\}^2} \left[-\log \{f, \infty\} \{f, 0\} \right]^{-a}$$

where $a > 1$ and k is the normalisation constant. After some further analysis it can be proved that

$$m_r\left[\frac{f'}{f}, \infty\right] \leqslant \tfrac{1}{2} \log [\lambda(r)] + a \log T(r) + 0\,(1)$$

where $\log \lambda(r) = 0[\log r + \log T(r)]$ except in the exceptional intervals. It should also be mentioned that this is the sharpest form in which the theorem is put. In fact if we work out the values of the actual constants we get a much sharper form than that obtained recently by Shimuzu and others.

K. V. I.

Uniform Distribution of Points.

KOKSMA ("Ein mengen theoretischen Satz uber die Gleich-verteilung modulo Eins," *Comp. Math.*, **2**, Fasc. 2, pp. 250–258) has

recently contributed an interesting theorem concerning the uniform distribution of points $\{\theta^n\} = \theta^n - [\theta^n]$ (*i.e.*, the fractional part of θ^n.) He has proved that the distribution of such points is uniform in (0, 1) for almost all $\theta > 1$ (*i.e.*, excluding a set of points of measure zero utmost.) The most important theorem he proves in this connection is the following:—Let α and β be real numbers $\alpha > \beta$. Let $f(x, \theta)$ be a real continuous function of θ in $\alpha \leqslant \theta \leqslant \beta$ for every +ve integral value of x. For every $x_1 \neq x_2$, let $\phi(x_1, x_2, \theta) = f(x_1, \theta) - f(x_2, \theta)$ be a continuously differentiable function of θ (*i.e.*, its differential derivate ϕ_θ' is monotomic and $\neq 0$. Let

$$A_N = \frac{1}{N^2} \sum_{x_1=2}^{N} \sum_{x_2=1}^{x_1=1} \text{Max} \left[\frac{1}{|\phi'\theta\,(x_1, x_2, \alpha)|} \right.$$

$$\left. \frac{1}{|\phi'\theta\,(x_1, x_2, \beta)|} \right]$$

and N_ν be a sequence such that ΣA_{N_ν} converges and $\frac{N_{\nu+1}}{N_\nu} \to 1$. Then $\{f(n, \theta)\}$ is uniformly distributed for almost all θ. The proof of this theorem is established by utilising Weyl's criterion, *viz.*,

$$\frac{1}{N} \sum_{1}^{N} e^{2\pi i f(n, \theta)} \to 0 \text{ with } N \to \infty.$$

From this the result follows as a particular case.

K. V. I.

Creation of the Radio-Elements belonging to a New Radioactive Family.

So far there were only three radioactive families known namely (1) the thorium series with atomic weights of the form $4n$ where n is an integer, (2) the radium series with mass numbers expressed by $W = 4n + 2$ and (3) the actinium series with $W = 4n + 3$. A series of the form $W = 4n + 1$ must consist of unstable elements since they do not occur normally in nature. Now I. Curie, H. von Alban Jr. and P. Preiswerk (*Journ. de Physique*, 1935, **6**, 361) have artificially produced some elements which they have definitely proved to belong to this family. Since Fermi has shown that slow neutrons have a large probability of being captured by a nucleus resulting in the formation of an isotope having the mass number greater by one, they bombarded Thorium with slow neutrons. The new element formed was expected to be β-active and hence to prove its existence, the Thorium had to be carefully purified to remove the radiothorium associated with it. After addition of Ba and Pb and Bi and precipitation with H_2SO_4 and H_2S respectively, La was added and the Thorium precipitated with H_2O_2. The hydroxide formed was converted into nitrate or chloride and dried before irradiation. The Thorium was placed in a bakelite case with a cellophane covering since such a case was found to be free from activity when irradiated. The β-activity was examined by means of a Geiger-Müller counter of thin aluminium 0·2 mm. thick. The activity curves were analysed and showed products of 1 min., 25 min. and 3·5 hrs. periods. These were chemically separated and then the repetition of the analysis showed two new products of periods 2·5 min. (associated with the 25 min. product) and 12 min. When the irradiated thorium was precipitated with H_2O_2, the 25 min. product came down with it showing that it is an isotope of Thorium. Addition of paraffin with consequent slowing down of the neutrons increased the yield of this product thus confirming the above view.

The 3·5 hrs. product accompanied La in the chemical separation thus showing itself to be an isotope of actinium. The 2·5 min. product was shown to arise from a Thorium isotope and to be an isotope of protactinium and hence the conclusion was drawn that the 2·5 min. product was produced from the 25 min. product. The several results could be explained on the basis of the following equations:

$$^{232}_{90}\text{Th} + {}^{1}_{0}n = {}^{233}_{90}\text{R}\ (25\ \text{min.})$$

$$^{233}_{90}\text{R}\ (25\ \text{min.}) \xrightarrow{\beta} {}^{233}_{91}\text{R}\ (2\cdot5\ \text{min.})$$

The production of the 1 min. product which was shown to be an isotope of radium was explained as follows:

$$^{232}_{90}\text{Th} + {}^{1}_{0}n = {}^{229}_{88}\text{R}\ (1\ \text{min.}) + {}^{4}_{2}\text{He}$$

$$^{229}_{88}\text{R}\ (1\ \text{min.}) \xrightarrow{\beta} {}^{229}_{89}\text{R}\ (3\cdot5\ \text{hrs})\ (\text{isotope of actinium})$$

The 12 min. product probably results from the process:

$$^{232}_{90}\text{Th} + {}^{1}_{0}n \to {}^{232}_{89}\text{R} + {}^{1}_{1}\text{H}.$$

Thus the new radioactive family is probably developed thus:

$$^{237}_{92}\text{R} \xrightarrow{\alpha} {}^{233}_{90}\text{R}\ (25\ \text{min.}) \xrightarrow{\beta} {}^{233}_{91}\text{R}\ (2\cdot5\ \text{min.}) \xrightarrow{\beta} {}^{233}_{92}\text{R} \xrightarrow{\alpha} \text{etc.}$$

A search for the origin of this family $^{237}_{92}\text{R}$ in Uranium minerals was however without result.

T. S. S.

Electrets.

M. EGUCHI performed a remarkable experiment in 1925. A suitable wax was poured in the molten state into a condenser, a voltage was applied, and the wax allowed to solidify under the electric stress. The result was a permanently electrified body, an "electret," which retained its charge constant over a period of more than a year. In a recent paper (*Phil. Mag.*, 1935, **20**, 929) A. Gemant has carefully studied these highly interesting electrical analogues of permanent magnets, and finds that there are two possible kinds of charges, one having the opposite sign to the adjacent polarising electrode, of short duration, and caused by ionic space charges. The other has the same sign as the adjacent polarising electrode. It is caused by orientation of dipole molecules leading to an oriented crystallisation and accompanied under circumstances by a secondary piezo electric effect. This charge is the steady one, and is of great interest. Technical applications for such electrets can be found in the construction of electrometers and in a kind of electrostatic microphone.

M. A. G. RAU.

The Hammersten Effects.

J. W. MCBAIN (*J. Am. Chem. Soc.*, 1935, **57**, 1916) has cleared up much of the confusion that has arisen by calling different Phenomenon "Hammersten Effect". Linderstörm-Lang conferred the name to the fact that the osmotic coefficient of the thymonucleates depends upon the size of the kation. Pauli and Valko and later others, included under this term the fact that in certain colloidal electrolytes the osmotic coefficient (obtained from freezing point lowering) is far less than that necessary to account for the hydrogen ion alone as measured by the electromotive force. McBain classes the former as the genuine Hammersten Effect and has put forth a new explanation of the same based on steric hindrance to close packing. The second phenomenon (the "Hammersten Effect" of Pauli) appears to be more fundamental in view of the considerations of McBain. The divergence between the freezing point and the electromotive force data finds a rational explanation on the basis that the activity coefficient of the hydrogen ion is about half of that of the chloride ion in the concentrated solutions of hydrochloric acid. This marks one of the very first steps in getting at the individual activity coefficients of the ions without making any arbitrary assumptions.

K. S. G. D.

The Use of Ortho-para Hydrogen Conversion in the Detection of Free Radicals.

THE fact that paramagnetic substances can catalyse the ortho-para conversion of hydrogen has been used for the first time in the detection of free radicals by W. West (*J. Am. Chem. Soc.*, 1935, **57**, 1931). He finds definite indications of the production of paramagnetic free radicals on illumination of methyl iodide and acetone. On the other hand, propionyl iodide does not seem to give rise to free radicals under similar conditions. This is pointed out as a strong evidence in support of Norrish's hypothesis of a difference in mechanism in the photodissociation of aliphatic aldehydes and ketones.

K. S. G. D.

Deuterium as an Indicator in the Study of Intermediary Metabolism.

IN a series of four papers published in the *Journal of Biological Chemistry* (1935, **111**, 163–192), Rudolf Schœnheiner and D. Rittenberg have published the results of their work on intermediary metabolism, employing a very elegant and novel technique. The difficulty of following the course of transportation of normal physiological substances in the body and their conversion into other substances has long been realised and very often laborious experiments have yielded uncertain results. While the use of synthetic derivatives for following the metabolism of physiological substances has yielded interesting results, the method is open to the objection that such derivatives are not natural, and it is open to doubt whether they successfully imitate the physiological substances whose metabolism is under investigation. By replacing one or more of the elements in the molecule of the substance, by their respective isotopes, it is reasonable to expect that the chemical properties of the substance will not be greatly altered. Schœnheiner and Rittenberg have employed this method and by replacing the hydrogen in the organic compound by its heavy isotope, deuterium, which is capable of being detected with a precision of 0·001 per cent. they are enabled to follow the fate of such substances after administration to animals. The employment

of deuterium as an indicator opens out a new chapter in the study of metabolism.

For a successful working of the method, the deuterium should be placed in the molecule in such a position that it is not interchangeable with the hydrogen of water. It was, therefore, necessary to introduce deuterium into carbon groupings by catalytic hydrogenation of unsaturated compounds. The application of the method is, therefore, restricted to the substances containing *stable* hydrogen. "A substance like oxalic acid cannot be investigated as the two hydrogens in it are labile." The method gives information only on processes in which the hydrogen (deuterium) remains fixed at the carbon atom, but not on the fate of these carbon atoms to which deuterium is not attached. There may be a few other reactions which restrict the universal application of the method and further work will be necessary to understand such limitations.

As a result of the experiments on mice fed from 2 to 10 days on a diet comprising 20 per cent., 4 per cent. and 1 per cent. deuterium-containing fats, the authors conclude that the largest part of the dietary fat, even when present in small quantities, is deposited in the fat tissues before it is utilised

The application of the method to the investigation of the intermediary products in the general cholesterol metabolism has yielded very interesting results. Thus, cholestenone is an intermediary substance in the sterol metabolism. It is probable that it is formed from the oxidation of cholesterol as a first step, and is then reduced to coprostanone.

Further applications of the method will be awaited with interest.

B. N. S.

On the Biology of the Psyllidæ (*Homoptera*).

THE work of R. U. Mathur (*Indian Forest Records*, 1935, Entomology Series, Vol. I, No. 2) on the biology of the *Psyllidæ*, furnishes important details about the habits, life-history and economic value of a family of insects that has long remained comparatively untouched by Entomologists in India generally; not only in economic (Forest) but in taxonomic entomology as well, this work supplies a long-felt want, specially for investigators in forest Psyllid fauna all over India; indeed these valuable notes will also guide economic entomologists in India, in their study of Psyllids, as affecting cultivated crops of all kinds.

B. K. M.

Immature Stages of Indian Coleoptera (*Scarabæoidea*) and Eucnomidæ.

THE studies of immature stages of Insects in general and of Coleoptera and Lepidoptera specially, cover a very large field and offer great scope. In insect classification, the custom has mostly always been to take into consideration the taxonomically valuable characters of the imaginable stages, to the utter exclusion of the several important features of the larval or immature stages. This has not only rendered classification incomplete but has made the task of Coleopterists and Lepidopterists, in specific determinations based on characters of larval instars, doubly difficult, and well-nigh impossible.

The descriptions of the immature stages of Scarabæoidea, particularly, are of vital interest to economic entomologists who have frequently to deal with the larval stages of Scarabiid, Melolonthid and Rutellid beetles; considerable damage is caused to the roots of cultivated crops of all kinds by them and an exact knowledge of their important features largely facilitates not only correct determination but effective control. Entomologists all over India welcome the valuable work of J. C. M. Gardner, (*Indian Forest Records*, 1935, Entomology Series, Vol. I, Nos. 1 and 4) on the immature stages of Coleoptera.

B. K. M.

Asexual Reproduction in Tunicates.

N. J. BERRILL in his paper on the Asexual Reproduction in the Tunicata ["Studies in Tunicate Development," *Phil. Trans. Royal Society, London*, (B), 1935, **225**, No. 526] has described the nature of budding in twenty genera of ascidians; eight of them are described for the first time, such as, Diazona, Tylobranchion, Morchellium, Euherdmania, Eudistoma, Archidistoma, Pycnoclavella and Chonorostachys. He has noted that the majority of the forms possess a regular alternation of sexual and asexual phases which coincide more or less with summer and winter, but the onset of budding seems to be dependent more on the physiological conditions of the animals than on the change of environment. The budding results in a tendency on the part of the zooid

to degenerate, the degeneration being brought about by autolysis or regression in an antero-posterior direction, which is associated with the formation of yolk-laden trophocytes. The posterior extension of migration of the trophocytes depends upon the presence or absence of the posterior-abdomen, enlarged ventral vessel and other similar factors. The medium of nutrition for the bud may be fluid where there is a physical continuity or by trophocytes in cases of physical isolation. During autolysis the tissues least specialised survive readily and the presence of at least one unspecialised cell is necessary to the development of a new individual, and buds are isolated from the parent by transverse constrictions and where a part of the old alimentary tube is present, the development is only a case of regeneration, while, where it is absent it is only reorganisation of the contained tissues. The author has contradicted the accepted view that the vascular septum of the ventral vessel has no connection whatever in embryonic development with the pericardium of the adult and hence cannot be considered as extension of the epicardium into the ventral stolon. He points out that though it is assumed that the mode of budding is primitive, there have been two major trends in specialisation, the one culminating in Distaplia, Diplosoma and probably Thaliacea where the type of budding is localised being epicardial and œsophageal, and the other through the posterior extension of zooids and buds to form Synoicids, Clavelinids and possibly ending in Perophoridæ, and the budding in the Botryllidæ and Polystylidæ is only a reacquisition of the faculty and not phyletically continuous with any other type.

Spermatogenesis of Man.

J. B. GATENBY AND H. W. BEAMS have for the first time described the behaviour of the Cytoplasmic inclusions during Spermatogenesis in man (*Quart. Journ. Micros. Sci.*, 1935, **78**, Pt. 1, No. 309). While the general behaviour of the constituents probably does not differ from that found in many other mammals, there are certain important variations which are pointed out by the authors. Three types of golgi apparatus can be distinguished; that in the sertoli cells being filamentar while it is sub-spherical in the spermatocytes and semi-dispersed in the spermatogonia. During division, the golgi apparatus breaks up into a large number of very small bodies which show a tendency of grouping round the nucleus rather than round the asters. The mitochondria are granular throughout and probably do not differ from the mitochondria in other mammals. The rôle of the centriole appears interesting. The single centriole of the spermatid soon divides into two which move close to the cell-membrane. The flagellum arises from both of them and the distal one becoming larger, assumes a ring-shape. The whole apparatus moves close to the nucleus and the proximal centriole is eventually seen to attach to the nuclear membrane. The distal ring-shaped centriole moves a certain distance down the flagellum and marks the posterior end of the middle piece. The authors describe a neck granule in addition to the two centrioles, embedded in the posterior part of the nucleus close to the proximal centriole. They do not attach any relation between this body and the centrioles and tend to think it is a derivative of the nucleus. The golgi apparatus takes very little part in the formation of the acrosome, a single bead-like body developing within the archoplasmic area becoming attached to the nuclear membrane and giving rise to the acrosome. The rest of the golgi apparatus is discarded. A post-nuclear cap is described. The sperm head has a vacuole whose function is not determined with certainty. Crystals, of either rod, batonette or pointed shape are found in a number of cell-elements of the testis and are probably no more than reserve nutriment in the cells.

The Cranial Morphology of Some Examples of Pelobatidæ (Anura).

W. K. PARKER described the gross structure of the skull of various anuran examples as early as 1881 and recently, however, the subject has received greater attention and has been studied by modern methods. In a paper in *Anat. Anz.* (Bd. 81, Nr. 4/6, S. 65–96) Mr. L. S. Ramaswami has described some aspects of the cranial morphology of the two pelobatid examples Scaphiopus and Megophrys. The cranial anatomical features of these forms are compared with those of the ancestral group "Liopelmidæ". Further, it is pointed out that Megophrys, which according to Noble occupies a basal position, anticipates some of the characters of the next group—the pelobatinæ, of which

Scaphiopus has been studied. Moreover, Scaphiopus possesses certain exclusively individual characters. Thus the Nobelian viewpoint, that in the order of evolution, Megophrynæ occupies the lowest while Sooglossinæ the highest rungs, is questioned. The author suggests that the three sub-families Megophrynæ, Pelobatinæ and Sooglossinæ are all of equal rank and they have moved on parallel lines.

The Atomic Nucleus.

[Prof. Born first explained how he had chosen to talk about the nucleus although his main line of work was not nuclear structure: the intimate touch with the pioneers in nuclear Physics, which he had during his stay at Cambridge, was influential in his choice. Incidentally he referred the audience to his new book *The Restless Universe* with its novel illustrations which produced the same impression as a cinematographic picture when the leaves of the book were rapidly turned over. The lecturer then proceeded to give a very lively discourse on the discovery and investigation of atomic nuclei.]

THE view that an atom consists of opposite electric charges concentrated at a great distance from each other and not uniformly distributed throughout the atom was put forward by Lenard in his theory of dynamides, long before Rutherford proposed the nuclear theory of the atom. The idea behind the attempts to unravel the mystery of the nucleus was to pierce it by swift particles and thus gain a knowledge of its contents just as a closed mechanism has to be taken to pieces in order to lay bare its inner details. The discovery of Radioactivity had placed such swift projectiles in the hands of the physicist. The radioactive elements like Uranium, Polonium and Radium emit three different kinds of radiation which were named α-, β- and γ-rays. The α-rays consist of helium atoms which have lost two electrons, the β-particles are swift electrons and the γ-rays are waves like X-rays but of higher frequency. It was natural that Rutherford who had done important work in Radioactivity should study the effect of bombarding different substances by means of α-particles. It was also natural that one of the best means of studying the tracks of these particles, *viz.*, the Wilson cloud chamber should have been invented in England which is famous for its fog. When a sudden expansion is caused to take place in a chamber saturated with water vapour, the fall of temperature produces supersaturation and the vapour will condense into drops wherever some dust or charged particles are present. Since the α-particles are heavy projectiles with high energy their path is thickly studded with charged ions and droplets forming on these show the track of the α-particle as a thick straight line. Just as the projectiles from a heavy gun spread swift destruction thickly along their path while the bullets from pistols produce here and there a chance casuality and are also more easily turned from their course, the β-particles in contrast to the α-rays, produce zig-zag tracks sparsely covered with droplets. The γ-rays, on the other hand, first produce electrons along their path and the tracks of the latter then show up the passage of the γ-rays.

The experiments of Rutherford on the scattering of α-particles showed that these particles were generally deflected by small amounts, but now and then there occurs a very large deviation. Rutherford saw that such a deviation was like the passage of a comet round the sun and applying a similar calculation he was able to deduce the distance to which the α-particle had approached the positively charged part of the atom in order to suffer such large deflections as were observed, and found the distances to be sub-atomic.

The periodic system of the elements assigns to each element a number denoting its place in the table called the atomic number. This was now identified by Mosely to be identical with the positive charge on the nucleus. The simplest nucleus is that of hydrogen having unit charge and is called the proton. The other charges are multiples of these but the chemical atomic weights of the various atoms are not exact multiples of the weight of a proton. The explanation was furnished by the work of J. J. Thomson on positive-ray parabolas and the refinement which Aston introduced by designing his mass-spectrograph. This work showed that the masses of the different atoms were really integral multiples of that of the proton, thus reviving Prout's hypothesis. The chemical atomic weights were shown to be different from integers because the chemical elements are mixtures of atoms of different mass but with the same charge. Such atoms occupy the same place in the periodic table and are called isotopes. The separation of isotopes is very difficult; but in the case of the most interesting isotope, *viz.*, the heavy isotope of hydrogen discovered by Urey (for which he obtained the Nobel Prize) has been separated, with the help of its most important compound: heavy water. G. Hertz has also succeeded in separating the isotopes of neon and of hydrogen by repeated diffusion through a large number of porcelain vessels connected to diffusion pumps. Prof. Born had seen his apparatus filling a large room and witnessed its working.

Starting from the nuclear model of the atom, Bohr assumed that the electron, *e.g.*, in the hydrogen atom was revolving round the nucleus but it could do so only at definite distances from the centre so that its angular momentum changed from one position to another by integral multiples of h—Planck's constant—and that the difference in the energy when an electron jumped from one orbit to another was radiated as a single quantum $h\nu$ of frequency ν. Bohr was thus able to explain Balmer's formula for the lines of hydrogen and to deduce the constant occurring in it with great accuracy. He elaborated his theory further by the correspondence consideration that in the limit, classical theory and quantum theory should lead

to the same result but there were a number of difficulties which were only removed by the Quantum Mechanics of Heisenberg and Schrödinger. According to this we no longer think of the electron as actually describing an orbit, but the orbits of the earlier theory with some modifications are the loci of the most probable positions of the electron. The quantum mechanics was also very successful in explaining how radioactive atoms send out quite by chance a particle now and then, though nobody can predict whether a particular atom is going to explode now or a hundred years hence. The explanation was offered by Gamow and by Gurney and Condon. The constituents of the nucleus have to overcome a large resistance due to their mutual attraction if they are to come out. According to classical ideas, they can never come out if their energy is less than that required to overcome this opposition while actually those that come out are shown by experiment to have an energy less than this. Taking the analogy of bodies within a crater wall, we see that they can fall outside the crater only if originally they were at a greater height. But if they were waves a certain fraction of the waves would pass through the wall as sound waves do, and if we assume the wall to become thinner at the top, waves passing near the top would penetrate easier. In a similar way the quantum mechanics associates the particles inside the nucleus with waves which have thinner barrier to pass through the larger of the energy particles and thus the fraction of these particles which comes out is the larger, the greater their energy. This is the explanation of the Geiger-Nuttall law in Radioactivity.

Further progress in our knowledge of the nucleus came from the work of Rutherford who bombarded Nitrogen with α-particles and showed that hydrogen was given out. Recent improvements in technique have enabled Cockroft and Walton and Lawrence to produce artificial missiles which disrupt a number of nuclei. Here again theoretical calculations by Gamow according to quantum mechanics showed first the possibility of breaking up the nucleus even with missiles having lower energy than the binding energy of the constituents of the nucleus, if the missile itself is caught by the nucleus.

The discovery of neutrons *i.e.* uncharged particles of the same mass as the hydrogen nucleus (proton) by Curie and Joliot and Chadwick cleared up a number of difficulties associated with the previous assumption that nuclei consist of protons and electrons. These neutrons do not produce tracks in a cloud chamber and they cannot be stopped by large thicknesses of such heavy metals as lead. But peculiarly enough they are absorbed by light substances rich in protons such as paraffin, and the protons which they dislodge can then be studied by means of their tracks and yield information about the neutrons. Heisenberg has developed a general theory of nuclei assuming them to contain only protons and neutrons and assuming a general expression for their interaction. Further advance is to be sought in a satisfactory theory of β-decay. In course of trying to explain the fact that in β-decay electrons of all energies are sent out and not merely discontinuous groups, Pauli suggested that along with the electrons uncharged particles of very small mass called neutrinos are emitted along with the electrons, and Fermi has developed this theory to a large extent. Interesting experiments have been made at Cambridge to detect these neutrinos. They may possibly be capable of penetrating miles of lead.

Another discovery foreshadowed by theory is that of the positron. Dirac had propounded a theory of the electron which showed that positive particles of similar mass should exist. Examining the " showers " of particles produced by Cosmic radiations, by means of a Wilson chamber placed in a magnetic field, Anderson detected electron tracks curved in opposite ways. By placing a sheet of lead across the chamber and finding on which side the energy decreased resulting in greater curvature of the path, he was able to demonstrate that the particles producing both classes of tracks were moving in the same direction and therefore opposite curvature indicated opposite charge. This proved the existence of positrons and also showed that a γ-ray produces an electron-positron pair. Thus matter has been created out of radiation as definitely proved later by Curie and Joliot. The reverse of this, namely, the annihilation of an electron-positron pair resulting in high frequency γ-radiation has also been observed.

Lastly must be mentioned the discovery of artificial radioactivity by Curie and Joliot, for which they have recently obtained the Nobel Prize. These observations give fresh information about the stability of the nuclei. But just at the present moment the definite structure of the nucleus is not yet known and much further progress will have to be made before the question is finally settled. We must find an explanation, for example, for the spins of nuclei, the spin being an important property in itself, but of special interest to the audience owing to the fact that Prof. Venkatesachar and his collaborators were engaged in its investigation. Further the magnetic moments of nuclei have to be interpreted in terms of the moments of the neutron and the proton ; the latter has been experimentally found by Stern to be 2.5/1840 Bohr Magnetons. However, said Prof. Born, this progress may be achieved in a short time, and with this expression of hope, he concluded his most interesting address which had kept a mixed audience of students and scientists spell-bound throughout the hour elapsed during its delivery.

T. S. S.

Properties, Characteristics and Uses of Stainless Steel.*

THE investigations on this important development of metallurgy during the last 25 years, and particularly after the war, have resulted in many brands of stainless steel, called by several names. It is, therefore, not surprising that Mr. Main should have found it difficult to give a single definition for stainless steels. The two varieties of this class of steel dealt with by the lecturer are really typical of this class. Now that there are several makes of almost the same kind of product, having practically the same chemical composition, it would perhaps be misleading to classify all of them under the same category. It would be better to name them by the chief characteristics which they possess such as acid-resisting, rust-free, heat-resisting, etc.

The chief characteristics of plain chromium steels largely used in the manufacture of cutlery have been dealt with in detail and attention is drawn to the prevailing belief that ordinary carbon steel gives greater hardness to the cutlery and retains it better than the stainless type. If stainless steel cutlery has to maintain the same reputation as plain carbon steel product and still be competitive with it, it would serve no practical purpose to improve hardness by adding other valuable elements and thus adding to the cost. It is a point for investigation if carbon itself could not be increased beyond the present limit of 0.35 per cent. keeping the chromium content round about 14 per cent. It is of course practically impossible to handle a product like the above with our present methods of heat treatment and new methods of working will have to be developed. This would incidentally help a larger use of the cheaper grades of high-carbon ferro-chrome.

There is no doubt that for decorative and household use the famous "18–8" variety is best suited. Here again the presence of a large quantity of nickel is making the product very expensive. The question whether an improved technique for the manufacture of stainless irons could be developed so that a cheaper substitute may be made available for the chrome-nickel type of stainless steel, deserves investigation.

Considerable work is at present being done in important Institutes of research with a view to determine the relative merits of different metals and alloys for containing foodstuffs. The author's statement that there is not the slightest fear of food contamination and consequent poisoning, in stainless steel vessels and that there is no anxiety on this score is very assuring.

The use of stainless steels in the chemical industries is perhaps much more extensive than in other fields. Almost all the important industries use this material in greater or smaller degree, and it is believed that the high initial cost paid for the stainless steel equipment is more than compensated by the saving due to absence of frequent repairs and renewals. It is hoped that in course of time some modified form of chrome-nickel stainless steel will be evolved which would resist the action of the two important acids, *viz.*, sulphuric and hydrochloric, which easily attack the present brands of stainless steel.

In the field of mechanical engineering the use of plain chromium steels is becoming more and more common. Most of the high pressure steam turbines have blades made of a special type of chromium-nickel steel. Pump impellers and parts of automobiles and aeroplanes are made of stainless steel. The stainless steel train referred to by the author is of special interest since the deterioration on ordinary steel trains due to corrosion is stated to be on the increase. Apart from the decrease in weight of the carriages, the absence of annual cleaning and painting and complete renewal perhaps once in about 12–15 years should make it worth while to take up a thorough investigation of the overall relative merits of the two types of rolling stock at least for fast express trains.

A reference is made to a series of new cheap alloy steels which resist corrosion better than the plain carbon steels, chiefly copper and copper chromium steels. But it is doubtful if any reasonably cheap steel could be produced which would be rust-free and at the same time capable of being rolled into the numerous sections used in structural Engineering.

A brief reference has been made to the manufacture of stainless steels, and the several manipulative processes required for finishing them. A passing mention may be made here of the new direct processes for manufacturing stainless steel. It is true that several of the present patents cannot be strictly called commercially successful, but one or two processes especially Wild's process, seems full of promise. The mechanical working of steel after the ingot stage has been receiving considerable attention and any improvement in the mechanical equipment handling this type of steel with a view to minimise rejections should be welcome. After all the demand for this type of special product is largely guided by the price at which it can be sold, and attempts must therefore be made in the direction of cheapening the cost of production during the several stages of manufacture.

The theory of protective film produced naturally on the steel, advanced by the author, is full of interest. The popular impression of stainless steels was that the stainless character is in the substance itself rather than due to any protective coating on the outside. The claim put forward by the manufacturers of stainless steel products that these products are superior to those having special coatings of chromium or nickel was largely based on this belief.

The several practical details given by the author in relation to cutlery steel, temper colours and the non-magnetic character of nickel steel, and the precautions that should be observed in working them should be very useful to the user of this class of steels. Reference to the recently discovered defect of intergranular corrosion when fabricating stainless steels and the special methods of overcoming it is also of practical value.

The future of stainless steel depends largely on the extent to which it can compete with its likely rivals in chemical industries and household utensils, these rivals being brass, bronze and

* "Properties, Characteristics and Uses of Stainless Steel," Lecture by S. A. Main, B.Sc., F.I.P., Royal Society of Arts, 1935, **83**, 672.

aluminium. The next step in the development of this class of steels should therefore be mainly in the direction of cheapening the cost of production. One method is to perfect the several practical details connected with the direct processes referred to above. These processes will involve the use of lower grades of chrome ore, thus conserving the richer chromium resources of the world for only highly specialised products. Just as the iron ores containing round about 30-35 per cent. of iron were considered 50 years ago as being quite uneconomical for conversion into iron, while now the same class of ore is largely used in blast furnaces in England and on the Continent, similarly the development of suitable methods for economical utilisation of large deposits of low grade chrome ores should prove of considerable help.

D. V. KRISHNA RAO.

Science Notes.

A Note on the Sapogenin from Soapnuts.—Dr. S. V. Shah, Rajaram College, Kolhapur, writes under date 16th November, 1935: "On referring to literature one finds that work on this sapogenin was begun by Winterstein and co-workers (Hoppe-Seyler's *Zeit. Physiol. Chem.*, 1911, **75**, 427; *Helv. Chim. Acta*, 1919, **2**, 198). But more recently W. A. Jacobs took up the same work (*J. Biol. Chem.*, 1925, **63**, 621; **64**, 379).

"According to Winterstein the sapogenin is a neutral optically inactive product having the molecular formula $C_{18}H_{28}O_3$, molecular weight 280, and melting point 319-320°. Jacobs described it to be dextro-rotatory [$(\alpha)_D$. 81°: l=1.009 in pyridine] and acidic in nature as it yields a sodium salt, and to have the molecular formula $C_{31}H_{50}O_4$. He thus found it to be exactly identical with hederagenin of Van der Haar (*Ber.*, 1921, **54**, 3142). For a moment one could argue that Winterstein's product was impure and as suspected by him was a mixture and the reduced optical activity was not observed in dilute solution.

"Further on treatment with concentrated nitric acid, Winterstein obtained from the sapogenin 1 : 5-dinitro- and 1 : 8-dinitro-naphthalenes. This appears more in support of Winterstein's than Jacobs' formula, as the removal of 21 carbon atoms from the molecule by nitric acid is rather unexpected. Windaus and Shah, Windaus and Linsert (*Zeit. Physiol. Chem.*, 1926, **151**, 86; 1925, **147**, 275) could not remove by this method more than five carbon atoms from oxydigitogenic, digitogenic and gitogenic acids. On the other hand, a degradation by eight carbon atoms (from 18 to 10) accepting Winterstein's formula appears more probable also according to recent work. Tschesche (*Ber.*, 1935, **1393**, 1412) has shown that the skeletons of digitogenin gitogenin and tigogenin have a side chain of eight carbon atoms in addition to four hydrogenated rings. In the case of these genins it is this side-chain which is attacked by nitric acid with the removal of five carbon atoms. By analogy, it is more probable, that, in the case of the soapnut sapogenin, eight carbon atoms would be removed by nitric acid instead of twenty-one carbon atoms thus supporting more the Winterstein's than Jacobs' formula for the sapogenin."

An Iron Horse from the Central Provinces.—Among the exhibits that were shown and commented upon at the ordinary monthly meeting of the Asiatic Society of Bengal, held on Monday, the 2nd December, was an iron horse. This exhibit which was shown by Sir Lewis Fermor "was obtained some 32 years ago from the top of a hill of manganese-ore in the Chhindwara district. The manganese-ore cropped out in large black masses, which in one place had been daubed with red paint and treated as a village god. Lying about were a number of clay horses and an iron one. This hill has since been worked as a manganese mine, and is now represented by a large hole in the ground.

The interest of this specimen is perhaps threefold. In the first place it has been exposed to the moist air of Calcutta for over 31 years, without any appearance of rust, from which one can deduce that it is made of very pure iron, as in the case of the iron pillar at Delhi. Its age, of course, is unknown.

The second point of interest is that it must be regarded as an example of primitive art. It is made mainly from three pieces of iron—one piece forming the head, the body and the tail, another piece the front pair of legs, and a third piece the hind pair. The way in which the pairs of legs are bent over the body provides a representation of a saddle. In addition, there are two extra small pieces of iron welded on to form the ears. Two touches of vermilion on the head suggest the eyes. The horse is so constructed as to be unstable when standing on its four feet, but to be stable standing on a tripod consisting of its hind legs and tail. It is a little over 7 inches long, and is in consequence less than one hand high.

I have shown this horse on occasion to many people, and no one appears to have seen a similar horse before, but—and this is the third point of interest—it has been suggested to me that it should be compared with the horses that are offered to the Southern Indian village deity known as *Iyenar*—a beneficent male deity, who is regarded as the village watchman and whose duty is to patrol the village and fields at night. If this suggestion is correct, it is an indication of the extension of this South Indian deity as far north as the Chhindwara district in the Central Provinces. An account of *Iyenar* is given in Bishop Whitehead's "Village Gods of Southern India". These village gods, according to Bishop Whitehead, date from before the Aryan invasion and must be regarded as Dravidian deities. The Gonds of the Central Provinces are, of course, Dravidians, and it is not, therefore, surprising that worship of this deity *Iyenar* may have extended to the Central Provinces. I was not, however, given any name for the deity, and have no knowledge whether there is any local name for *Iyenar* in the Central Provinces."

The Food of 'Peking Man'.—An answer to the interesting question "what constituted the food of the earliest man-like animals?" has been provided by the painstaking excavations of the bone-bearing masses of breccia conducted by the members of the National Geological Survey of China. The living quarters of the Peking man, *Sinanthropus pekingensis*, dating back to the beginning of Pleistacene or Ice Age, have been recently unearthed, in which are found, in addition to the skulls and human teeth of the oldest inhabitants, stone implements, hearths and uneaten fragments of food. These afford evidence regarding the dietary habits of the early man (*cf.*, "The food of Peking man," *News Service Bulletin, Carnegie Institute of Washington*, 1935, 3, No. 25). Crudely fashioned flakes of quartz served to cut and scrape. Several feet of ashes piled against the walls of the cave show that the early man knew the use of fire. In the ashes have been discovered bits of incompletely burnt wood and abundant fragments of charred bones. The Peking man must have used game animals for his food. Thousands of fragments of shells of hackberry seeds occurring in the breccia, constitute the earliest record of the use of plant food by the prehistoric man. These berries were perhaps used to flavour the meat, as is being done by the natives of the South-West of Armenia to this day. We have thus a good record of the feeding habits of the Peking man preserved through the obscurity of over a million years.

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Timber Research. (His Majesty's Stationery Office, Price 1*s.* 6*d.*).—The Report of the Forest Products Research Board for the Year 1934 gives an account of the progress made during the year in the investigation of the many and varied problems concerned with the efficient utilisation of timber. The work covers a wide field and involves the study of the physical, mechanical and seasoning properties and the working qualities of timbers, and the control of fungal and insect pests. The Report cannot fail to interest those concerned with the handling and use of timber, research into which means large economies to the timber-using industries and professions.

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Indian Central Cotton Committee, November 1935.—(1) DEVELOPMENT OF COTTON CULTIVATION IN SIND:—*Botanical Work.*—Replicated field-scale trials of the improved Sind American types 289 F–1, now known as 'Sind Sudhar' cotton, 285 F–2 and 4F–98, together with the improved *deshi* type 27 W.N. were conducted both at Sakrand and at the Government Seed Farm, Mirpurkhas. Progress was made in the selection work with Punjab-American cottons and more extensive trials with a new and promising strain namely 289 F–20 were conducted at Mirpurkhas. African cotton types A 12 and U 4, were obtained and similarly tested. Bulk samples of imported Uganda, Morad (Egyptian) and Sudan cottons are also being studied by the staff of the Botanical Section and put to further tests. *Physiological Investigations.*—The study of factors responsible for 'red leaf' blight on American and Egyptian cottons grown in Sind with the object of obtaining information regarding the possibility of control of this disease, or the breeding of resistant types has been continued. The Indian Central Cotton Committee in conjunction with the Imperial Council of Agricultural Research, made a grant of Rs. 16,030 in January 1933, for a period of three and a half years for an enquiry into the cost of production of cotton and sugarcane with their rotating crops in Sind. *Sind Cotton Extension Scheme.*—The activities covered by this scheme, financed by the Indian Central Cotton Committee are being pursued in two Sections, one in the Left Bank areas and the other in the Right Bank areas of the River Indus. In the Left Bank Section, tests carried on with regard to the respective yields and suitability for extension of different varieties of cotton, in Thar Parkar, Nawabshah and Hyderabad Districts have demonstrated the high yielding capacity of 289 F–1, 4 F–98 and (*Deshi*) 27 W. N. Plots for the cultivation of these varieties were laid down at three centres and the best methods of growing them were shown to the cultivators. In the Right Bank Section—hitherto a non-cotton growing area—the work on thirty-five demonstration plots in the Dadu, Larkhana and Sukkar Districts, brought promising results from the growing of 4 F–98, 1500 acres were cultivated under cotton in *Kharif* season of 1933 and there was every indication of a further extension of cotton cultivation in this area. Seed of improved varieties of cotton sufficient for the cultivation of 4,000 acres was distributed and intensive propaganda was conducted in the districts to induce Zamindars to take up cotton cultivation.

During the year 1935–36 the cotton area on the Right Bank is over 16,000 acres which is about four times of what it was in the previous year.

The interesting point during the year has been that the area has been mostly under the American variety and the *deshi* has been eliminated from the tract.

(2) FIBRE-MATURITY IN RELATION TO FIBRE AND YARN CHARACTERISTICS OF INDIAN COTTONS: The exact relationships between the maturity count of cotton and its fibre properties on the one hand and the number of knotted and tangled fibres, technically known as 'neps' in the yarn, on the other, have been investigated by Dr. Nazir Ahmad and Mr. Amar Nath Gulati. The results showed that the variety known as *C.A.* 9 tops the list, having over 80 per cent. of fibres fully mature, while in *Goghari E.* 2, which comes at the bottom of the list, only 14 per cent. of mature fibres were observed. It was also found that cottons like *Mollisoni* produced practically 'nep' free yarns while type 413 contained as many as 19 'neps' per yard and could only be described as exceedingly neppy. The investigators then proceeded to study the influence of such factors as season, locality of growth, heredity, etc., on the degree of fibre maturity of a cotton and the relationship of the latter with fibre properties and yarn characteristics.

As a result of these investigations it is concluded that (*a*) Mature fibres are on the whole stronger than either half-mature or immature fibres. (*b*) Percentage of immature hairs in a cotton has an important bearing on the formation of 'neps' in yarns and cotton comprising a high percentage of immature hairs are likely to give rise to yarns containing proportionately large number of 'neps'. (*c*) There is no

significant relation between maturity and staple length, but detailed analysis showed that a majority of short stapled cotton possessed high percentages of mature fibres while a majority of comparatively long stapled cottons are characterised by low percentages of mature hairs. (*d*) On a detailed analysis it was found that in medium and long stapled cottons higher fibre-maturity was usually associated with better spinning performance, while in short stapled cottons the reverse was the case.

These results are embodied in Bulletin No. 20, issued by the Technological Laboratory of the Indian Central Cotton Committee (Price as. 8). The Bulletin describes the technical details of the tests employed in the investigation and is illustrated with charts and interesting photo-micrographs.

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Oxidation and Scaling of Heated Solid Metals. (His Majesty's Stationery Office. Price 2*s.* 6*d.* net).—This volume issued by the Department of Scientific and Industrial Research contains a full critical review by acknowledged experts of the recent work on oxidation and scaling of heated solid metals summarising existing information and drawing attention to problems requiring further research. It is mainly concerned with the mechanism and rate of oxidation and properties of oxide layers, but it also contains sections describing the practical effects of oxidation and scaling and the methods of prevention to be employed.

* * *

New Applications for Superphosphate.—The Research Institute for Fertilisers and Insectifungicides has recently established that double superphosphate from apatite and thermic phosphoric acid with a total content of 50·17 per cent. of phosphoric acid gives positive results when used for the dry treatment of millet and wheat seed against smut. Six grams of superphosphate per kg. of seed proved sufficient. Field experiments have shown that millet and wheat seeds treated in this way did not suffer from smut, whereas on the check plots sown from untreated seeds the smut infestation was as much as 30 per cent. The germination rate of wheat was somewhat reduced, whereas millet retained its germination rate.—(*Industrial and Eng. Chem.*, 1935, **13**, 406.)

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Harrison's Chronometers at the Science Museum.—The Science Museum, South Kensington, has recently acquired on loan, by courtesy of the Admiralty, all four of the pioneer marine time-keepers made by John Harrison between 1729 and 1759. With these instruments Harrison was the first to show that it was possible to construct a portable time-keeper which would keep sufficiently accurate time at sea to be of use in determining a vessel's longitude, and thus solved the problem of "finding the longitude", which had baffled men of science and inventors for over 200 years. Harrison's instruments were the first balance-wheel time-keepers to embody any kind of compensation for the effects of change of temperature. In all his four instruments compensation is provided by varying the effective length of the balance-spring, the mechanical details varying in the different individuals. The first three time-keepers are large clocks each weighing over 50 lbs., but the fourth is much smaller, being in the form of a large watch a little above 5 ins. in diameter. The third and fourth instruments, in particular, are of great complexity and were obsolete even in Harrison's life-time, for after he had shown the possibility of constructing an accurate marine time-keeper other makers were able to devise simpler means of achieving the same ends. All four of Harrison's instruments have been cleaned, repaired and put into working order by Lt.-Commander R. T. Gould, and they are now on exhibition in the Museum in working condition.—(*J. of Sci. Instruments*, 1935, **12**, 339.)

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Radio Feeler.—A radio device reputed to enable a ship to "feel" its way through fog has been tested on the French "*Normande*". A radio beam of a wave-length of 16 centimetres describes an arc of 45 degrees in the direction of the ship's travel and if the beam is intercepted by any obstacle in its path, a loud speaker announces the fact to officers on the bridge. It is stated that objects have been detected at distances up to four miles.—(*Wireless World*, 1935, **37**, 491.)

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Plasticised Sulphur in Road Construction.—Experiments at the Mellon Institute indicate that plasticised sulphur which may be made by reacting sulphur with organic sulphides, poly-sulphides or polymers of these, can be used successfully as a binder for brick in road construction. Test panels subjected to heat showed no signs of the material exuding at temperatures well above the range met in pavements. A test road will be constructed by the State of Ohio next Spring. Plasticised sulphur gives a very fluid material at the temperature of application which is about 300° F.—(*Canadian Chemist and Metallurgist*, 1935, **19**, 279-35.)

* * *

A New Organic Reagent.—Rhenium, which was recently discovered, is being manufactured in Germany on a commercial basis, as it appears to have some industrial uses. Many attempts have been made to evolve a method for the analysis of the metal, but so far without success. It is now reported (*Chemical Age*, 1935, **33**, 441) that a new radical, tetraphenylarsonium, prepared from triphenyl arsine has been discovered by Bucke and Monroe, which can be successfully employed in the determination of Rhenium. Tetraphenylarsonium-per-rhenate is a crystalline and extremely insoluble precipitate with a high molecular weight and hence is well suited to the precipitation of this metal and its separation from other metals.

A very sensitive volumetric method for the estimation of iodine as well as the arsonium base itself, can be worked up by utilising tetraphenylarsonium chloride which forms an extremely insoluble periodate. As this chloride forms insoluble compounds with chlorides of cadmium, zinc, antimony, tin, mercury, quadrivalent lead, bismuth, platinum, gold, it can be successfully employed for the quantitative analysis of these metals. Very rapid estimations of zinc, cadmium, mercury, platinum and gold have been made by making use of this fact, with a high degree of accuracy.

American Stratosphere Balloon, Explorer II.—A notable achievement falls to the credit of Captain A. W. Stevens and Earl A. Anderson of the U.S. Army Air Corps, who, according to the reports in the daily press, have successfully piloted their stratosphere balloon up to the record height of 74,000 feet. The previous record was held by the ill-fated Russian balloon *Osoaviakhim* which probably reached a height of 72,000 feet on January 30, 1934. After the first set-back of last July, when the top of *Explorer* II burst and released 375,000 cubic feet of helium, another occurred on Monday, November 11, when a 20 feet rent in the envelope produced during its inflation, had to be repaired at the last moment. The ascent was made at 7 a.m. from a point eleven miles west of Rapid City, and a safe landing was made in the evening at White Lake, South Dakota. Capt. Stevens reported by wireless that at his maximum height the external temperature was — 55°C., the cosmic ray intensity 150 times at earth's surface and that the sky had become a jet black awning.—(*Nature*, 1935, **136**, 785.)

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Animal Experiments in the Investigation of Diseases.—The achievements of Louis Pasteur and Robert Koch have established the importance of animal experiments in the study of the cause and cure of diseases. In a valuable article published in *Research and Progress* (1935, **1**, 188) Professor Paul Uhlenhuth of the University of Freiburg, has furnished a brief account of the more recent researches on the nature of the diseases and the biology of the germs causing them. Weils disease, or infectious jaundice which was so prevalent during the Great War, is caused by *Spirochaeta icterohaemorrhagiae*; the experiments leading to this discovery were carried out on guinea-pigs. The deficiency diseases are all studied through animal experiments. Not only are animals used for discovering the causal agencies but also as means of diagnosing difficult cases of infectious diseases; mouse is used in the diagnosis of anthrax and tetanus and guinea-pig for the diagnosis of glanders and particularly of tuberculosis. Experiments with rats and guinea-pigs are officially prescribed for diagnosing small-pox and rabies. Another way in which animals have proved valuable in diagnosing diseases is in the agglutinin and bacteriolytic reactions. The precipitin test offers an extremely sensitive and valuable test in the identification of specific proteins and finds several applications, as for instance in the detection of adulteration of foods. The same reaction has served to establish the blood relation of the horse and the donkey, of the dog and the fox and of the man and the ape. The remedial and protective sera used in combating diseases are obtained from animals; the examples of such are found in antidiphtheritic and antitetanus sera. Animals also give the important vaccines—those against small-pox, rabies, etc. Experiments with animals form the basis of chemo-therapy and have assisted in the discovery of arsenical preparations for syphilis, antimony preparations for kalaazar etc. Chemo-therapeutic research through experiments with animals has ultimate possibilities of discovering remedies for the so-called incurable diseases such as, cancer, and bacterial infections (*sepsis, typhus*, etc.)

World Petroleum Congress.—The Association Francaise des Techniciens du Petrolu have issued an invitation to hold the World Petroleum Congress, 2nd Session, in Paris, in June or July 1937. The Council of the Institution of Petroleum Technologists have accepted the invitation. The task of organising will devolve on the French Association but the Council of the Institute of Petroleum Technologists will remain in close touch with the arrangements.

* * *

Third World Power Conference.—It is announced that the Third World Power Conference will be held in Washington, U. S. A., from September 7 to 12, 1936. The general subject to be discussed at the Conference is the National Power Economy. The 2nd Congress of the International Commission on Large Dams of the World Power Conference will be held in Washington at the same time.

* * *

12th Conference of International Union of Chemistry.—The Executive Committee have changed the opening date of the Conference to Sunday, August 16, 1936, and will close on Saturday, August 22. The conference will be held in Luzern. An excursion to Zurich will be arranged on August 19. All communications are to be addressed to Fr. Fichter, Laboratorium des Kantons-Chemikers, Vonmattltrase, 16, Luzern, Switzerland.

* * *

The All-India Medical Research Workers' Conference was held at Calcutta during the first week of this month. Major-General Sir Francis Connor, Officiating Director-General of Medical Services, opened the Conference.

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The Fourth All-India Industrial Exhibition will be held in Delhi, from February 29th, 1936.

* * *

Broadcasting in India.—A Radio Exhibition was held in Bombay on 9th December. Mr. Lionel Fieldon, Controllor of Broadcasting in India, opened the Exhibition. In the course of his speech, Mr. Fieldon said that the Government hoped to call a Conference of Representatives of States and Provinces, to discuss the future development of broadcasting. Dealing with the future, he said that "broadcasting was the gift of science to the people which, if used, with intelligence and impartiality, would infuse in the people, the spirit of good-will and mutual understanding and be a bridge to the millennium."

* * *

The John Fritz Gold Medal for 1936 has been awarded to Prof. William Frederick Durand of the Stanford University. Prof. Durand is an authority in hydro-dynamic and æro-dynamic science and in its practical application, he is an outstanding leader in research and in Engineering Education. It may be mentioned that this medal will be awarded each year for 'notable scientific or industrial achievement'.

* * *

Mr. T. H. Ritchie, M.A., B.Sc., Director of Agriculture, Central Provinces, has been appointed Director of Agriculture, U. P. Mr. T. C. McDougall, M.A., B.Sc., I.A.S., succeeded Mr. Ritchie as Director of Agriculture, C.P.

We are glad to announce that Dr. Subrahmanyan Chandrasekhar, Fellow of the Trinity College, Cambridge, has been appointed Lecturer in Cosmic Physics at Harvard University.

* * *

Lieut.-Col. R. N. Chopra, I.M.S., has been appointed Honorary Physician to His Majesty the King, in succession to Major-General Sir Robert McCarrison, retired. Lieut.-Col. Chopra has been promoted to the rank of Brevet Colonel.

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The honorary degree of Ph.D., has been conferred on Dewan Bahadur L. K. Ananthakrishna Iyer by the Breslau University.

* * *

The Degree of Doctor of Science (D.Sc.) has been conferred on Dr. S. V. Desai, by the Senate of the London University.

* * *

Doctor Sir Upendra Nath Brahmachari has been re-appointed by the Senate of the Calcutta University to the Court of the Indian Institute of Science, Bangalore, for the period 1936–40.

* * *

The Imperial Bureau of Soil Science, has recently issued a complete "Bibliography of Soil Science, Fertilizers and General Agronomy" covering the whole scientific literature of the world on soil and allied sciences during 1931–34. This extremely comprehensive Bibliography gives the reference to practically every paper published during that period on the different branches of soil science, both pure and applied, on the use of fertilisers, on the cultivation of all the chief economic crops (over 140, including forests, are listed in the index) and on plant diseases in relation to soils. The references are arranged by subjects according to the Universal Decimal Classification, which is adequately explained in the Preface. The volume also contains an index to the Decimal Classification, an alphabetical cross-index to every subject on which the papers listed have been written, an author index containing over 4,000 names, and a list of the abbreviations used, and the full titles and places of issue (where known) of 800 journals, etc., from which the references in the Bibliography have been taken.

The Bibliography has been compiled from the references which appeared in the first 41 issues of the Bureau's monthly lists of *Publications Relating to Soils and Fertilisers*. An unusual feature is that the literature of almost every country has been covered equally well, thanks to the exceptional facilities for procuring foreign periodicals which the Soil Bureau enjoys. Considering its scope and the amount of information it contains, the book has been made remarkably compact, without detriment to its readability. It should be a most valuable reference book to every agricultural scientist whose work is, in any way, connected with the soil. The Bureau intends to issue further similar bibliographies at intervals of 3–4 years, and in this way gradually to build up a complete reference library to the whole literature of the soil over an extended period of time.

Crown Octavo, pp. 504. Bound in cloth, with gold lettering, price 25/- net; post free, from the Imperial Bureau of Soil Science, Harpenden, England.

Announcements.

The Society for the Study and Promotion of Family Hygiene.—A new organisation whose aim is, broadly, to help in increasing happiness in the marital and family relationships and ensuring a general improvement of the human races, has recently been started at Bombay. The Society aims to provide facilities for research and proposes to (1) grant scholarships and endowments for stimulating and organising research, (2) publish reports, leaflets, dealing with topics connected with family, marriage and allied subjects in their social and biological aspects, (3) organise propaganda for the introduction of sex education in schools and other teaching institutions, (4) start consultation centres and contraceptive clinics for promoting family and marriage hygiene, (5) hold periodical conferences and arrange lectures, (6) make available to members, a library containing selected scientific books, (7) collect and collate manuscripts, press cuttings, etc., (8) build up a museum for education purposes, etc., etc. The promoters expect that the Society would either expand into an international organisation in due course, or would be affiliated with similar organisations in other parts of the world.

An all-India Council and the different Provincial Councils are under formation. The membership is open to adults of both sexes who are in sympathy with the objects of the Society. The annual subscription will be Rs. 10 for members and Rs. 15 for Fellows. Further information regarding the Society can be obtained from the General Secretary, Society for the Study and Promotion of Family Hygiene, Kodak House, Hornby Road, Fort, Bombay.

* * *

The First All-India Obstetric and Gynæcological Congress, 1936.—Under the joint auspices of the Bombay Obstetric and Gynæcological Society and the Obstetric and Gynæcological Society of Southern India, the first All-India Obstetric and Gynæcological Congress will be held at Madras on the 2nd, 3rd and 4th January, 1936. Subjects to be considered will be discussed under three sections, *viz.*, Obstetric section, Gynæcological section and Maternity and Child-Welfare section. A scientific exhibition of scientific appliances, foodstuffs, drugs and scientific books, will be held during the session. All communications should be addressed to the President of the Obstetric and Gynæcological Society of Southern India, Government Hospital for Women and Children, Egmore, Madras.

* * *

First Indian Population Conference.—The Conference will be held on January 27–28, in Lucknow, with Sir U. N. Brahmachari as General President. Prof. Radha Kamal Mukherjee, is the convener of the Conference. Discussions on problems of social biology and hygiene, vital statistics, production and population trends in various Provinces, etc., will be held during the Conference.

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We acknowledge with thanks the receipt of the following :—

"The Agricultural Gazette of New South Wales," Vol. XLVI, Pt. 11.

"The Allahabad Farmer," Vol. IX, No. 6, Nov. 1935.

"Journal of Agricultural Research," Vol. 51, No. 3, and Index to Vol. 50.

"The Journal of the Royal Society of Arts," Vol. LXXXIII, Nos. 4327–4330.

"Biochemical Journal," Vol. 29, No. 10, October, 1935.
"American Journal of Botany," Vol. 22, No. 9, November 1935.
"The Journal of Institute of Brewing," Vol. XLI (Vol. XXXII—New Series), No. 11.
"Chemical Age," Vol. 33, Nos. 852–855.
"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 11.
"The Journal of Indian Chemical Society," Vol. 12, No. 10, October 1935.
"The Cambridge Bulletin," Vol. LXXVII, November 1935.
"Experimental Station Record," Vol. 73, No. 5, November 1935.
"Journal of Entomology and Zoology", Vol. 27, Nos. 2–3.
"Forschungen and Fortschritte," Jahrgang 11, Nos. 31–33.
"Indian Forest Records," Vol. I, No. 5.—Entomology. Neue Attelabiden Aus Indien (*Curculionidæ*, Col.), by Edward Voss.
"The Punjab Irrigation Research Institute," Vol. II, No. 7, Nov. 1934—A Siltometer for Studying Size Distribution of Silts and Sands.
— Do. —Vol. IV, No. 7, 1934—Soil Deterioration in the Canal Irrigated Areas of the Punjab, Part I. Equilibrium between Ca and Na-Ion in Base Exchange Reactions.
— Do. —Part II. Relation between Degree of Alkalisation and Dispersion Coefficient in Deteriorated Soils (Vol. IV, No. 8, February).
Report of the Lac Research Institute for July 1935.
Report of the Indian Central Cotton Committee —(Its objects, activities and achievements.)
Dominion of Canada—Department of Agriculture :—
(1) Canadian Wool Grading and Marketing, by A. A. MacMillan, Livestock Branch, Bull. No. 181—New Series.
(2) The Cranberry Industry—Its Possibilities in Canada, by M. B. Davis with a Section on Insects affecting Cranberry, by F. C. Gilliatt and a Section on Cranberry Diseases, by K. A. Harrison (Bulletin No. 180—New Series)—Division of Horticulture.
(3) Capons and Caponizing by George Robertson and S. S. Munro—Bulletin No. 167, Division of Poultry Husbandry.
(4) The Gladiolus Thrips, by Alan G. Dustan, Bull. No. 151—Entomological Branch.
"The Review of Applied Mycology," Vol. XIV, Pt. 10, Oct. 1935 (Issued by the Imperial Mycological Institute).
"Proceedings of the Academy of Sciences of the U.P. of Agra and Oudh", Allahabad, Vol. IV, 1934–35.
— Do. —Session 1934–35 (Part V, Vol. IV).
— Do. —Part I, Vol. V.
"Medico-Surgical Suggestions," Vol. 4, No. 10, Oct. 1935.
"Report on the Administration of the Meteorological Department of the Government of India in 1934–35."
"Nagpur College Agricultural Magazine," Vol. 10, No. 2, Nov. 1935.
"Nature," Vol. 136, Nos. 3443–3446.
"The Journal of Nutrition," Vol. 10, No. 4.
"The Journal of Chemical Physics," Vol. 3, No. 11.
"Journal de chemie Physique," Vol. 32, No. 8.
"Russian Journal of General Chemistry," Vol. LXVII, Nos. 4, 6 and 7.
"Science and Culture," Vol. I, No. 7, December 1935.
"London Shellac Research Bureau, Technical Papers," Nos. 1–5.
"The Indian Trade Journal," Vol. CXIX, Nos. 1534–1537.
"Indian Journal of Veterinary Science and Animal Husbandry," Vol. V, Pt. III, September 1935.
"Transactions of the Faraday Society," Vol. XXXI, Part 11, Nov. 1935.
(The London Shellac Research Bureau.)
"Abstracts bearing on Shellac Research Literature for the Period 1st Jan. 1928 to 31st Dec. 1933."

Researches on Desert Plants.

THE peninsula of Baja (or lower) California, by reason of its extreme aridity and isolation has developed many species of plants peculiar to it. Dr. Forrest Shreve of the Desert Laboratory of Carnegie Institute of Washington recently led an expedition into these regions to investigate (1) the influence of extreme aridity and of the proximity of the sea on the plant life, and (2) the contrasts between the floras of the Gulf and Pacific slopes and the differences between the same latitudes on the peninsula and the main land. The study of the flora itself is full of significance "with the long history of its origin from its ancestral stock, its migratory movements, and its constant need of either finding just the right life condition, or else adjusting itself to the one that it is able to find." An account of the results of this expedition is published in the *News Service Bulletin, Carnegie Institute of Washington*, 1935, **111, No. 26.**

In 1934 and for several previous years the area did not have any rain. In the beginning of 1935, there was rain for several weeks, and the larger plants were in leaf and blossom, and the ground was covered with a carpet of short-lived anuals. Most of the plants that impart character to the landscape of Baja California, are either found nowhere else or occur sparingly in Sonora. In sharp contrast with the plants that live in rainy climates where their only struggle is with one another, the desert plants do not interfere with other plants and their struggle is with the environment. This results in the development of a large number of types each of which is capable of winning the battle with the environment in a different way. The most outstanding plant in Baja California is 'Cirio' (*Idria columnaris*). Next comes 'torote' (*Pachycormus discolor*), the giant 'yucca' (*Yucca valida*), the large century plant (*Agare goldmaniana*), the giant cactus (*Pachycereus pringleü*), the 'Ocotolla' (*Fouquieria peninsularis*) and the 'creeping devil' (*Machærocereus eruca*). The cirio and the 3 species of ocotillo have developed a mechanism of withstanding desert conditions which is unlike that of cacti or, for that matter, any other plant in the world. The leaves which make the food materials necessary for the plant, fall off after the rainy season and the stems are protected from desiccation by horny layers of tissue impregnated with resin just beneath the barks.

Academies and Societies.

Indian Academy of Sciences :

November 1935. SECTION A.—S. SIDDIQUI AND Z. AHMAD : *Alkaloids from the Seeds of* Cassia absus, *Linn.*—Two water soluble isomeric quarternary bases, to be called chaksine and iso-chaksine have been isolated. S. SIDDIQUI : *Studies in the Conessine Series. Part I.—Isomerisation of Conessine and its Nor-Bases.*—The isomerisation effected through the action of concentrated sulphuric acid on the corresponding bases in the cold has been studied. Iso-conessine is about thrice as potent as conessine. R. P. DODWADMATH AND T. S. WHEELER : *Studies in the Chemistry of Chalcones and Chalcone-Oxides. I. Phenyl-(3·4-methylene-dioxy-styryl)-ketone.*—The effects of presence of other groups in the nuclei on the reactivity of chalcones and chalcone-oxides are reported. R. ANANTHAKRISHNAN : *Some New Features in the Raman Spectra of Carbon and Silicon Tetrachlorides.*—Octaves of fundamental frequencies and their differential tones are recorded. C. S. VENKATESWARAN : *The Fluorescence of Ruby, Sapphire and Emerald.*—The photo-luminescence of the natural crystals has been studied at room-temperature and a number of new bands are observed. T. S. WHEELER : *On the Theory of Liquids—V.*—A summarised presentation of the theory developed in the previous papers of this series. S. BHAGAVANTAM : *Raman Spectrum of Deuterium: II.—Intensity and Polarisation Characters.*—The results when compared with those calculated from the theory of rotational Raman scattering due to Manneback, show satisfactory agreement. P. S. REGE AND T. S. WHEELER : *A Study of the Benzoin Reaction-IV.—The Kinetics of the Benzoin Reaction in the Presence of Organic Solvents.*—With inert solvents the heterogeneous reaction is unaffected. but the homogenous reaction is decelerated. The action of hydroxy compounds is complicated, but on the whole, they accelerate the reaction. K. NEELAKANTAM, T. R. SESHADRI AND R. H. RAMACHANDRA RAO : *Pigments of Cotton Flowers.—Part II.—Uppam* (Gossypium herbaceum).—The main components are *gossypitrin and quercetin.*—A new glucosidic pigment and a small quantity of gossypetin have also been isolated. S. PARTHASARATHY : *Determination of Ultrasonic Velocity in 52 Organic Liquids.*—The velocity depends upon chemical constitution. The adiabatic compressibilities of all the liquids have also been calculated. A. N. KAPPANNA : *Kinetics of the Reaction between a-Brompropionate and Silver Ions.—A Heterogeneous Reaction taking place on the Surface of Silver Bromide.* S. W. CHINCHALKAR : *Magnetic Birefringence in Solutions of Organic Substances. Part I.*—Aromatic hydrocarbons containing two or more benzene rings have been studied.

November 1935. SECTION B.—MAKUND BEHARI LAL : *On the Morphology of a New Species of Monostome of the Genus* Notocotylus *Diesing*, 1839.—Specimens of monostomes have been described as a new species of the genus *Notocotylus.* A. C. JOSHI : *Secondary Thickening in the Stem and Root of* Stellera Chamæjasmæ *Linn.*—The anatomy of the stem and root of *Stellera Chamæjasmæ*, a member of the family Thymelæceæ, has been described. B. N. SINGH AND K. KUMAR : *An Analysis of the Influence of Season on Photosynthesis in the Tropics.*—Leaves adopt their structure and function according to the intensity of external factors, and the specific adoptability is mainly brought about by suitable changes in the internal factors investigated. MAKUND BEHARI LAL : *A Review of the Genus,* Notocotylus, *with Description of a New Trematode Parasite of* Mareca penelope *from Lucknow.*—A new form belonging to the genus *Hindia*, but differing from the known species of the genus in the number and arrangement of the ventral glands, the arrangement of the uterine coils and the anterior extent of the vitellaria, has been described. ALBERTO CARLOS GERMANO DA SILVA CORREIA : *The Marathas of Portuguese India.*—From an anthropometric point of view, the Marathas do not constitute a race, nor can they be considered as belonging to an only caste, though the majority of them may belong to the *chatria.* FROILANO DE MELLO : *New Hæmoproteids of Some Indian Birds.*—New species of hæmoproteids have been recorded. L. B. KAJALE : *The Female Gametophyle of* Alternanthera sessilis *R. Br.* A. C. JOSHI AND J. VENKATESWARLU : *Embryological Studies in the Lythraceæ. I.* Lawsonia inermis *Linn.*—The development of the normal 8-nucleate embryo-sac, the double and triple embryo-sacs and degenerations in the embryo-sac are described.

The U. P. Academy of Sciences :

September 1935. B. L. GULATEE : *On the Subterranean Mass-Anomalies in India.*—From the isostatic gravity anomalies in India, a distribution of mass anomalies expressed as a coating of normal crustal density in the reference surface has been determined. S. SUBRAMANIAN : *The Closure Property of Three Curves.* G. R. TOSHNIWAL AND B. D. PANT : *Measurement of Ionisation of the Kennelly-Heaviside Layer at Allahabad.*—The ionisation of the E region has been found in the month of April. The morning critical frequency was in the neighbourhood of 3.1 Mc./sec. at 8 A.M. The maximum critical frequency of 4.6 Mc./sec. was observed on the 18th April during the so-called "evening concentration". R. N. GHOSH AND L. P. VERMA : *On the Application of Heaviside's Operational Methods to the Solution of the Pianoforte Problem.* HRISHIKESHA TRIVEDI : *The Absorption Spectra of the Vapours of the Mono-Oxides of Copper, Iron, Nickel and Cobalt and the Determination of their Heats of Sublimation.* HRISHIKESHA TRIVEDI : *The Absorption Spectra of the Vapours of the Mono-Sulphides of Iron, Nickel, Cobalt and Copper and the Determination of their Heats of Sublimation.* S. S. JOSHI AND K. P. N. PANNIKAR : *The Variations of Viscosity during the Coagulation of Colloidal Aluminium Hydroxide by Potassium Chloride Solutions.*—The Progress of Coagulation at lowest concentrations of the electrolyte is sensibly discontinuous in the beginning. S. M. MEHTA : *Effect of Temperature on Borax Solutions in the Presence of Polyhydric Substances and Organic Acids.* RADHA RAMAN AGARWAL AND SIKHIBHUSHAN DUTT : *Chemical Examination of the Bark of* Terminalia Arjuna *Bedd. Part I.—The Isolation of Arjunin.*—An acidic principle, "arjunin" has been isolated, m. p. 192° C., $C_{26}H_{32}O_{11}$. SIKHIBHUSHAN DUTT : *Chemical Examination of* Glycosmis Pentaphylla *and the Constitution and Synthesis of its Active Principles.*—"Glycosmin" which is a crystalline glucoside

has been found to be a veratroyl derivative of salicin. N. R. DHAR AND S. K. MUKHERJEE: *Further Experiments on the Fixation of Atmospheric Nitrogen in the Soil and the Utilisation of Molasses as a Fertiliser.*—Molasses used as a manure, increases the yield of sugarcane to the extent of 36 per cent. M. B. MIRZA: Physaloptera Achari *N.Sp. from* Calotes versicolor *with a Short Note on Abnormalities in the Genus* Physaloptera.—A number of worms obtained from the stomach, small and large intestines, of *Calotes versicolor* found in Hyderabad, Deccan, has been described. HAR DAYAL SRIVASTAVA: *Studies on the Family* Heterophydae *Odhner*, 1911. *Part II.*—"*Four New Parasites of the Genus* Haplorchis *Looss*, 1899," *From Indian Fresh-Water Fishes with a Revision of the Genus.* B. P. PANDE: *Contributions to the Digenetic Trematodes of the Microchiroptera of Northern India. Part II.—Studies on the Genus* Lecithodendrium *Loose.* H. R. MEHRA: *New Trematodes of the Family Lecithodendriidae Odhner*, 1911, *with a Discussion on the Classification of the Family.*—The account of a new genus *Exolidendrium* from the Indian gharial *Gavialis gangeticis*, and two new species of the genus *Eumegacetes* Looss from an Ashy Swallow-Shrike is given.

31*st October* 1935. S. C. DAMLE: *A Note on Sir Shah Muhammad Sulaiman's New Theory of Relativity.*—The degrees of accuracy of the two differential equations of motion obtained by Sir M. Sulaiman in Section V (Chapter I) of his theory dealing with Planetary Orbit were different. To maintain the same degree of accuracy, in both equations, the term containing the first differential coefficient of the distance from the centre should be retained in the first of the equations. When this term is retained in the first equation and other corrections introduced in the second, the value obtained for the rotation of the perihelion of mercury in one complete revolution is numerically one-sixth of the usually accepted value and in the opposite direction. N. R. DHAR AND S. K. MUKERJEE: *Use of Molasses in the Reclamation of Alkali and Usar Lands.*—Reclamation of alkali soils is possible by the application of Molasses to the extent of 90–360 maunds per acre. Crops have been raised on such reclaimed soils with good yields. N. R. DHAR AND S. P. TANDON: *Influence of Temperature on the Fixation of Nitrogen by Azotobacter.*—Nitrogen fixation by Azotobacter takes place best at 35°C.; sunlight and azotobacter are the two potent agencies which serve to meet nitrogen requirements of tropical soils. A. M. D'ROZARIO: *On Two New* Xiphidiocercaria *from the Common Fresh-Water Snail,* Indoplanorbis exustus *(Deshayes) of the Northern India.*

5*th November* 1935. S. PRADHAN: *The Genetalia and Their Role in Copulation in* Epilachna indica *(Coccinellidae: coleoptera) with a Discussion on the Morphology of the Genetalia in the Family.*—The structure, disposition and the mode of working of the muscles of the male and female genetalia of *Epilachna indica* were described. H. TRIVEDI: *The Absorption Spectrum of Hydrogen Bromide Molecule and its Upper Unstable State.*—An experimental verification of the author's theory of continuous absorption of a diatomic molecule by means of which it is possible to deduce the nature of the repulsive state. V. V. NARLIKAR AND D. N. MOGHE: *A Note on a General Line-Element.* D. N. MOGHE AND R. V. SASTRY: *The Field of a Non-Static Spherical Condensation.* SATYENDRA RAY: *The First Universal Principle of Sulaiman.* SATYENDRA RAY: *On Two Mutually Contradictory Interpretations of Einstein's Line-element by Sulaiman.* K. L. GUPTA: *On the Convergence and the Summability of the Conjugate Series of the Derived Fourier Series.* S. M. SANE AND A. B. SEN: *On Some Toluen Sulphonyl Esters of Phenols.* M. RAMAN NAYAR: *Variation of Physical Properties with Change in Concentration of Iodic Acid Solution.* UMAKANT SHUKLA: *Necessary and Sufficient Condition for the Equality of*

$$\frac{d}{dy}\int_a^b f(x,y)\,dx \text{ and } \int_a^b \left[\frac{d}{dy}\{f(x,y)\}\right]dx$$

B. M. GUPTA: *On the Relationship Between the Soluble Fatty Acids and the Potash Equivalent of Acids giving Barium Salts.* A. C. CHATTERJI: *Influence of Lyophillic Colloids on the Wettability of Naphthalin.*—The power to wet and the protective effect of lyophillic colloids bear a very close relation to each other, both being due to absorption of the colloid by the respective particles.

Indian Chemical Society:

October 1935. HANS KRALL AND RAMESWAR DAYAL GUPTA: *The Phenylthiocarbamides.—A Contribution to the Study of the Triad,-N-C-S—. Part I.—Aniline Thiocyanate.* SANATSARAN MEHTA AND HANS KRALL: *The Phenylthiocarbamides.—A Contribution to the Study of the Triad.-N-C-S-.—Part II.—Action of Hydrolytic Agents on Phenylthiocarbamide.* SANATSARAN MEHTA AND HANS KRALL: *The Phenylthiocarbamides.—A Contribution to the Study of the Triad. —N-C-S-.—Part III.—Action of Nitrous Acid on Phenylthiocarbamide.* DINES CHANDRA SEN: *Studies in the Camphor Series.—Part I.* L. MCMASTER AND C. R. NOLLER: *The Formation of Amides from Nitriles by the Action of Hydrogen Peroxide.* H. K. SEN, KANAILAL ROY AND PANKOJ ROY: *Note on a Routine Gas Analysis Apparatus.* SISIR KUMAR GUHA: *Studies in Indigoid Dyes.* UMAPRASANNA BASU AND BASUDEB BANERJEE: *Synthesis in the Pyridine Series. —Part II.* NIRMALAPADA CHATTERJEE: *The Coagulation of Ferrocyanide Sols Containing Varying Amounts of Potassium Ferrocyanide.* B. B. DEY: *Preparation of Resorcinol Monomethyl Ether (A Correction).*

Asiatic Society of Bengal:

November 1935. (MEDICAL SECTION). *Live fishes inspected in the food and air passages of man.*—At the recent Meeting of the Medical Section of the Asiatic Society of Bengal, Dr. S. L. HORA of the Indian Zoological Survey addressed the members on the recent Indian cases of live fish found in the human pharynx and air passage. The Surgical aspect of such cases was presented by Lt.-Col. B. G. Mallaya. Dr. E. W. Gudger had reported 38 cases of live fish impacted in the pharynx and air passage, which were compiled from records covering the period from 1567 to 1933. Nearly 32 per cent. of such accidents are

said to have occurred in India and Burma. Dr. Hora instituted further enquiries into such calamitous occurrences and has collected information regarding 19 more cases; altogether there have been 31 authenticated reports of such accidents in India. On mapping out the distribution of these misfortunes according to the provinces where they occurred and according to the types of fish producing them, Dr. Hora has placed the latter in the following order of delinquency.—*Anabas testidinens* responsible for 17 cases; *Colisa Fasciatax*, 4; *Mustacembelus*, *Nandus* and *Cynoglossus*, 1 each; 7 undetected. Out of the 19 recent cases, the Madras Presidency claims 6, Assam 5, Burma and Bihar and Orissa 3 each, Bengal and Bombay Presidency 1 each. In Dr. Gudger's Indian cases, the offending fishes were found in the pharynx of the victims; Dr. Hora reports that in 13 cases, fishes were lodged in the food passage and in 6, he found them insinuated in the air passage: more than 63 per cent. of these cases proved fatal.

Dealing with the surgical treatment of fish obstruction Lt.-Col. Mallaya observed that the condition of the patient and the position of the fish must determine the line and the extent of operative interference. A foreign body blocking the vital passages must rapidly produce suffocation and Dr. Mallaya suggested that in view of the extreme urgency of all such cases, a tracheotomy or pharyngotomy performed even with a pocket knife would relieve respiratory embarrassment, and in other less desperate cases where only the nasopharyngeal passage is affected, perhaps a pair of long forceps might suffice to provide relief. The removal of the fish from the passages must be at once delicate and difficult for the obvious reason that the animal may remain alive for some time and may be bristling with spines. Accidents of this kind must be due to follies. Further history of such cases of live fish being impacted, regarding age, sex and occupation of the victims must throw light upon the immediate causes of accidents.

Meteorological Office Colloquium, Poona:

Four meetings were held during November 1935. At the first of these held on the 4th, Father M. Selga of the Phillippines Weather Bureau addressed the gathering on "Typhoons and Weather in the Phillippines" and described the organisation of the Weather Service in the Islands; also, Father R. Raphæl of the St. Xavier's College, Bombay, who was in Quetta at the time of the big earthquake, gave an account of some personal impressions in respect of the same. The programme at the three remaining meetings was as follows:—

12-11-35.—Mr. P. K. Raman: "Some recent work on problems relating to the thermal balance at the earth's surface."

19-11-35.—Dr. S. K. Banerji: "Calculation of velocity and acceleration of a system of isobars."

26-11-35.—Mr. M. S. Katti: "Some recent work on meteorology in relation to the soil."

University and Educational Intelligence.

Andhra University:

Applications will be received by the Registrar Andhra University, Waltair, for the following posts in the University Colleges:—

Professor of Economics.
Professor of Politics.
Professor of Pure Chemistry.
Professor of Applied Chemistry.

Salary Rs. 800—50/2—1,000.

The Syndicate will be prepared to consider higher terms in exceptional cases. Further particulars can be had from the Registrar.

Sir J. C. Coyajee, Professor of Economics, has resigned his appointment. He was Professor of Economics for nearly three years.

A Diploma course in Librarianship has been introduced in the University.

The M.A. (Hons.), M.Sc. (Hons.), and Ph.D. degrees were awarded for the first time this year, to candidates for research work done by them.

Allahabad University:

Pandit Iqbal Narain Gurtu was elected Vice-Chancellor of the Allahabad University, at a meeting of the Council held on the 4th December.

Aligarh Muslim University.

The Academic Council of the Aligarh Muslim University decided at its meeting held on 13th November to accept the thesis submitted for the Ph.D. Degree in Physics by Mr. Mohd. Jan Khan. As examiners Sir C. V. Raman, Dr. W. Jevons, Imperial College, London, and Prof. R. Samuel, Aligarh, have been appointed. The thesis comprises two parts. In part I, the candidate has worked out the absorption spectra of a number of polyatomic molecules and shows that the ground state of molecules formed by a central atom in a higher state of valency does not arise from the ground state of a molecule formed by atoms of lower valency but from an excited level. The second part deals with the spectra of SeO and SeO_2, the vibrational analysis of which is given. The constants of these molecules show a close correspondence. Both these results clearly indicate a strong localisation of the bonds.

Benares Hindu University:

New Appointments.—In the new session which commenced in July, eleven new appointments were made. The following are some of the important ones:—

(1) Rao Bahadur K. V. Rangaswami Aiyangar, M.A. (Madras), appointed Principal of the C. H. College of Arts and University Professor of Economics.

(2) Dr. S. K. Belvalkar, M.A. (Bom.), Ph.D. (Harvard), I.E.S., appointed University Professor of Samskrit.

(3) Dr. P. N. Roy, M.A. (Cal.), D.Litt. (Rome), appointed Professor of Modern European Languages.

(4) Dr. Mrs. Indumati B. Adarkar, M.B.B.S. (Bom.), D.L.O., M.R.C.S. (London), appointed Lecturer in Domestic Science for the Women's College.

Faculties.—At the Annual Meetings of the Faculties held on November 29 and 30, 1935, the following gentlemen were elected Deans :—

Faculty of Law : The Rt. Hon'ble Dr. Sir Tej Bahadur Sapru, K.C.S.I., M.A., LL.D.

Faculty of Arts : Prof. P. B. Adhikari, M.A.

Faculty of Science : Prof. P. K. Dutt, M.A. (Cantab.)

Faculty of Oriental Learning : MM. Pandit Pramatha Nath Tarkabhushan.

Faculty of Theology : Pandit Vidyadhar Gaud.

Faculty of Ayurveda (Medicine and Surgery): MM. Kaviraj Dr. Gananath Sen, M.A., M.D., L.M.S.

Academic Questions.—The University was one of the earliest in the country to start a number of technical and professional courses which have hitherto been under the Faculty of Science. With a view to greater efficiency the Senate has proposed the establishment of a separate Faculty of Technology. The necessary Regulations have been framed and submitted to the Visitor for sanction. The Senate has also under consideration the introduction of a diploma course in Pharmaceuticals.

University Library.—The University Library is now housed in a commodious and magnificent building constructed at a cost of Rupees Three Lakhs which was received as a donation from H. H. The Gaekwad of Baroda. During the year 1934-35, 8,547 volumes were added bringing the grand total of books to about 80,000. The new accession includes 5,725 volumes valued at Rs. 50,000 and received as a gift from the Kanju Mulji Charitable Trust of Bombay.

The University Training Corps.—The corps has returned from the Annual Camps of the Battalion held at Bareilly from Nov. 1 to 15. It won the Efficiency Cup for the ninth time in succession and annexed several other prizes and trophies. Besides providing armoury, parade ground and residential quarters the University has recently constructed a 400 yards' classification Shooting Range at a total cost of Rs. 6,000.

University of Bombay:

Royal Institute of Science.—Dr. Mata Prasad, Professor of Inorganic and Physical Chemistry, has been elected a Fellow of the National Institute of Sciences, India.

The 1st annual meeting of the Indian Academy of Sciences, was held here from 18th to 20th of December. It was opened by H. E. the Governor of Bombay. Mr. V. N. Chandavarkar, the Vice-Chancellor of the Bombay University, was the Chairman of the Reception Committee.

Calcutta University:

The Senate of the Calcutta University has donated Rs. 5,000 to the Indian Institute of Medical Research, out of the Sir P. C. Roy Fellowship Fund, and sanctioned a grant of Rs. 1,200 to Dr. G. N. Roy, Professor of Chemistry, Carmichael Medical College, to enable him to carry on research on Epidemic Dropsy.

University of Mysore:

1. The Senate held its ordinary meeting for the year on 21st November, 1935. At the meeting, the Senate resolved to recommend the conferment of the Degree of Doctor of Laws on Rajasabhabhushana Diwan Bahadur Sir K. P. Puttanna Chetty. A proposal to declare the results of the Master's Degree examination in two classes (first and second) was referred to the Academic Council. A proposal to institute a section providing balanced diet in hostels was discussed. The University authorities will further consider the proposal.

2. Dr. A. Subba Rau, B.A., D.Sc. (Lond.), F.R.M.S., Professor of Physiology, Medical College, was elected by the Senate of this University as its representative on the Court of the Indian Institute of Science, Bangalore, for the period, 1936–40.

3. The following Extension Lectures were delivered :—

(i) Mr. Devudu Narasimha Sastry, M.A., on (*a*) "Kalidasana Sandesa" ; (*b*) "Karnataka Samskruti" ; in Kannada at Nanjangud, Mysore and Chickballapur.

(ii) Mrs. Iqbalunnisa Hussain, B.A., Dip.Ed. (Leeds), on (*a*) "My experiences in an English University" in English at Bangalore and Mysore; (*b*) "Education of Muslim Women" in Urdu at Bangalore and Channapatna.

4. Mr. K. S. K. Iyengar, B.A. (Cantab.), Professor of Mathematics, Central College, proceeded on leave for one month and 18 days from 6th November, 1935.

Central Board of Education:

FULL LIST OF MEMBERS.

Ex-officio.—(1) Sir Girja Shanker Bajpai, Member-in-charge of the Department of Education, Health and Lands (Chairman), and (2) Sir George Anderson, Educational Commissioner with the Government of India.

Nominated by the Government of India.—(3) Sir T. B. Sapru, (4) Sir Akbar Hydari, (5) Dr. A. H. Mackenzie, (6) Right Rev. G. D. Barne, (7) Lady Grigg, and (8) Srimati Rajkumari Amrit Kaur.

Elected by the Council of State.—(9) Sir K. Ramunni Menon.

Elected by the Legislative Assembly.—(10) Dr. Ziauddin Ahmed, and (11) Dr. Bhagwandas.

Nominated by the Inter-University Board.—(12) Mr. Shyamaprasad Mookerjee, Vice-Chancellor, Calcutta University, (13) Sir S. Radhakrishnan, Vice-Chancellor, Andhra University, and (14) Dr. R. P. Paranjpye, Vice-Chancellor, Lucknow University.

Representatives of Local Governments—Either the Minister of Education or his deputy, Director of Public Instruction or his deputy.—(15) The Director of Public Instruction, Madras, (16) the Director of Public Instruction, Bombay, (17) the Minister-in-charge of Education, Bengal, (18) Sir J. Srivastava, Minister of Education, United Provinces, (19) the Director of Public Instruction, Punjab, (20) Dr. Ba Maw, Minister of Education, Burma, (21) the Minister of Education, Bihar and Orissa, (22) Mr. B. G. Kharpade, Minister of Education, Central Provinces, (23) the Director of Public Instruction, Assam, and (24) the Director of Public Instruction, North-West Frontier Province.

Reviews.

"Mathematics and the Question of Cosmic Mind," with Other Essays. By C. J. Keyser. ("Scripta Mathematica", Yeshiva College, Amsterdam Avenue and 186th Street, New York, U.S.A.) 1935. Pp. 128. 75 cents.

This book is No. 2, in the Scripta Mathematica Library series of which No. 1 was reviewed in these columns previously. According to the author the book, at least the greater part of it, is written for those who should like to think, and not for the multitude who are satisfied with being merely told. The volume is composed of six essays,—all reprints,—two being popular expositions of the mathematical method and one a popular discussion of that most discussed subject—whether the external world is real. In the essay on "Mitigating the tragedy of our modern culture" the author puts in a powerful plea for more earnest attempts on the part of the specialists to popularise their work so as to reach "the intellectual laymen" and reviews the notable attempts of Reichenbach, Weyl, Lewis, Levy, Jeans and Eddington. It certainly gives us great pleasure to add to these the name of the eminent author of these essays. In the essay dealing with Law (he calls it legal science), we are shown how mathematising will benefit the subject immensely though there are obvious limitations of a formidable character. The last essay is merely an appreciative article on the life of the late Prof. W. B. Smith, a great mathematician and a versatile scholar.

The book is well got up notwithstanding the misprints which occur (*e.g.*, on pages 56, 89, etc.) and is very readable, the language throughout being frankly journalistic. The purpose of the promoters of the movement is eminently served by the two books so far issued and we may confidently look forward to more illuminating works of a similar nature in future. As No. 1 in the series bears the name *Poetry of Mathematics and Other Essays*, it would not have in the least been inappropriate if this had been named *Meaning of Mathematics and Other Essays*.

B. M. N.

Mechanical Properties of Matter. By S. G. Starling, B.Sc., A.R.C.Sc., F.Inst.P. (Macmillan & Co., Ltd., London.) 1935. Pp. viii + 336. Price 6*sh*.

There are but a few text-books on Properties of Matter at present available in English and a new book by the author of the much-used *Electricity and Magnetism* is a welcome addition. The book comes entirely up to our expectations and has the same conciseness and clarity that distinguish the other books of the author. Though primarily meant for Higher School Certificate and Intermediate students, such free use of simple Calculus has been made that with a very few additions here and there, *e.g.*, in connection with Gravitation, the book will meet the utmost needs of the B.A. and B.Sc. Pass students of our Universities. In fact the chapters on "Flow of Liquids and Gases" and "Waves" contain more information than is usually required from such students and help to put them in touch with useful results in Hydrodynamics deduced in a simple way. The large number of graded exercises appended to the several chapters will serve to give the student a thorough grounding and the really numerous worked examples are models which can be entirely recommended.

Exception has to be taken, however, to one or two features in this otherwise excellent book. The half-hearted introduction of vector notation leads to some equations which are meaningless. The fault is mostly due to introducing division by a vector as if it were an ordinary scalar. Thus $\frac{u_2' - u_1'}{u_1 - u_2} = e$ on p. 30, $f \times s$ meaning fs on p. 34 and $\frac{v^2}{r}$ on the same page will lead the student to an unwarranted liberty in operations with a vector. On p. 77 $\frac{v^2}{r}$ is called the radial acceleration: this is misleading. $\frac{v^2}{r}$ is the acceleration along the normal which happens to coincide with the radius in the case of the circle. The equation $\frac{dv}{dt} = r\frac{d\omega}{dt} + \frac{v^2}{r}$ on p. 76 would mean that along the radius there are two accelerations $r\frac{d\omega}{dt}$ and $+\frac{v^2}{r}$ both of which are false conclusions. The introduction of the vector notation is a progressive step, but the little addition that would make the notation consistent is not beyond the grasp of the students who use the book, and could easily be introduced. On p. 96 there is a misprint reading "holes are drilled the bar" and on p. 175 we once read "liquified". The

correction for the buoyancy of air in weighing should be $m_1 = m_2\left(1 - \frac{\delta_3}{\delta_2} + \frac{\delta_3}{\delta_1}\right)$ while on p. 165 it is written as if $m_1 = m_2\left(1 - \frac{\delta_3}{\delta_1}\right)$.

These small blemishes are indicated with the sole idea of making the book as unexceptionable as possible, for we may be sure that such a good text will see numerous editions and will serve generations of students. We have no hesitation in recommending the book to the Pass students of our Universities. The low price is most inviting.

T. S. S.

Elements of Strength of Materials. By Messrs. S. Timoshenko and Gleason H. MacCullough. (Messrs. Macmillan & Co.) 1935. Pp. 350. Price 14*s*.

The authors have brought out an exceedingly useful book. There are a large number of text-books on the subject but the presentation of the subject by the authors is so good that one's interest to read the book is increased as he proceeds and at the same time, due to the inclusion of alternative methods of solving many of the problems the subject is made very clear. The authors have in addition included at the end, chapters on " Energy of Strain " and on the various modern strength theories which will give just an idea to the students about the practical realities of the strength of materials and working stresses. But in the chapter on riveted joints while discussing the failures of joints by various causes, they have recommended that the distance between the centre of the hole and the edge of the plate should be between $1\frac{3}{4}$ to 2 times the diameter of the rivet, while the British practice recommends only $1\frac{1}{2}$ times the diameter. Again, for double shear the resistance is assumed to be double that for single shear, while the usual practice is to assume only $1\frac{3}{4}$ times that of single shear resistances, since it is not possible to ensure uniform distribution of loads. The authors could have, with benefit, included the formulæ for the design of rivets for given thickness of plates and design of cover plates in the case of butt joints, and also graphical determination of pitch by band method. Except for these shortcomings the book is a very good one and can be used as a text-book in the Colleges and Schools of Engineering.

The Publishers must also be congratulated on the neat printing and get-up of the book; there are very few errors and the printing is such as not to strain the eyes.

E. K. R.

Mercury Arc Rectifier Practice. By Mr. F. C. Orchard, A.M.I.E.E. (Chapman & Hall, Ltd., London.) 1935. Pp. 224. Price 15 *sh*.

This book deals clearly and concisely with a subject of growing importance, and will be found equally useful by students as well as practising engineers. The author explains in simple terms, with the help of clear diagrams, the principles underlying the action of the rectifier, its evolution and construction. The writer also deals in a very practical and comprehensive manner with the installation, operation, maintenance and testing of rectifier sub-stations. The chapter on grid control indicating, as it does, some important applications and possible lines of future development, adds greatly to the value of the book. The diagrams are excellent. The concluding chapter gives the relative advantages and disadvantages of the rectifier as compared with rotating machinery for sub-station work. The appendix contains some useful tables and a bibliography is added.

C. A. K.

Inorganic Colloid Chemistry, Vol. II. The Hydrous Oxides and Hydroxides. By H. B. Weiser, Professor of Chemistry at the Rice Institute. (John Wiley & Sons.) 1935. Pp. 429. Price 23/6.

The book deals with the methods of preparation, the properties and the uses of oxides and hydroxides in the colloidal condition. Ten years ago the author published a book on the Hydrous Oxides. The present volume, however, is not a mere revision of the earlier work. As stated by the author in the preface, most of the chapters have been entirely rewritten embodying the latest developments in this rapidly expanding branch of physical chemistry. The numerous observations recorded in the book have been examined critically and special emphasis has been laid on those aspects of the study of colloidal oxides as have led to the development of colloid chemistry on the theoretical as well as the applied side.

The first chapter is introductory in nature and deals in general with the preparation and properties of hydrous oxides and gels. The oxides are studied in detail in the subsequent chapters. The treatment of the hydrous oxides of iron, aluminium, chromium and

silicon is particularly exhaustive. The last four chapters deal with the technical applications of the hydrous oxides in mordant dyeing, mineral tanning and water purification.

The book is to be welcomed as a valuable reference work by colloid chemists and will be equally useful to the teachers and students of chemistry as the information is presented in a clear manner — characteristic of all the publications by Professor Weiser.

B. S. RAO.

Colloids in Agriculture. By C. E. Marshall, M.Sc., Ph.D. (Edward Arnold & Co., London.) 1935. Pp. 184. Price 5*s*.

The publication of this book is a sign of the increasing extent in which the teachings and methods of physical chemistry and of colloidal science are being drawn upon in building up the scientific basis of the studies of soil. Dr. Marshall's work on soil problems specially that on the X-ray analysis of clay minerals is well known and the book fulfils every expectation as to a clear, critical, concise and accurate exposition of the subject-matter. The book has been written with an eye to the requirements of " country organisers, district lecturers and rural instructors—indeed, to all who are engaged in scientific agriculture and who are interested in the application of our latest knowledge to their field work and their teaching " as also of " agricultural students": in other words, both for instructors and students. It serves this purpose most admirably. In the short compass of 184 pages,demy size, the subject-matter is treated under the heads, the nature of colloids, the formation of colloids, the properties of small particles in suspension, the properties of molecules at surfaces, ions at surfaces, soils and gels, the mineral colloids of soil, the organic colloids of soil, colloids in soil formation processes, colloids and soil texture, some colloidal materials present in living organisms, colloidal architecture in biological structures, milk and milk products as colloidal systems, smoke damage and plant protection. The book incorporates the latest information though naturally it is possible to indicate only the broader principles in so short a space. It has also the merit of using a lucid and descriptive style and avoiding such intricacies as are unsuitable for the class of readers the author has in view. It seems, however, that the student, in order to intelligently grasp the subject, must have a good knowledge of the fundamentals and of more complicated allied phenomena which would supplement the skeletal framework given in the book. This need is met by the author by the addition of lists of reference books at the end of each chapter with short notes for guiding the student.

The appearance of this book following in close succession those of Professors Robinson and Comber and the latest edition of Sir John Russell's well-known book now places at the disposal of English-knowing students of soil science an excellent account of the present position of our knowledge and tendencies of the development of soil science.

The reviewer was particularly interested to notice that the book correctly reflects the present position of our knowledge regarding the following:

(*a*) Coagulation by electrolytes seldom takes place at the isoelectric point and quite often at a cataphoretic speed higher than that of the particles of the sol not mixed with an electrolyte. It may be mentioned that during the aggregation of the particles the cataphoretic speed most often rises and then sharply falls when the colloidal solution loses a visible homogeneous appearance. The text-books on colloids give a wrong picture in this respect.

(*b*) An electric double layer may be formed on the surface of a particle by the adsorption of ions as distinct from the dissociation of adsorbed or surface molecules already present. It may be stated that this idea of dissociation of surface molecules requires to be supplemented by an answer to the question as to why a part of the dissociated molecules remains attached to the surface and the other part is, relatively speaking, more able to diffuse into the liquid and give rise to the double layer. The use of the terms, mobile ions and primary adsorption, is also specially welcome to the writer. They give a better idea of the conditions obtaining in the double layer. Perhaps the mention of the electrical adsorption would have given a more definite picture of the double layer. The subjects of the adsorption of ions, and of base saturation capacity, and the degree of saturation in relation to texture, pH and the Hissink, T, S, and V values might have been treated somewhat more in detail.

No student of agriculture can afford to do without a copy of this book.

J. N. M.

Annual Review of Biochemistry, Vol. IV. Edited by James Murray Luck. (Annual Review of Biochemistry Ltd., Stanford University P.O., California, 1935.) Pp. vii +639. Price $ 5·00.

The policy adopted by the *Review* is neither to encompass the whole field of Biochemistry within a single volume nor to adhere rigidly year after year to a given list of topics, but to discuss a bunch of papers relating to a definite aspect of Biochemistry or to a certain point of view. The chemistry of proteins and amino acids reviewed by Professor Cohn is a fine example of how stray and apparently unrelated papers have been marshalled and integrated to yield a comprehensive and a stimulating review of the subject from a physiochemical standpoint.

The Editors have been fortunate in securing the services of several authorities in their respective fields and this circumstance while raising the prestige of the *Review*, renders it highly informative and inspiring. Such reviews are useful in acquainting the reader with the processes which lead to the creation of new knowledge and by way of example particular attention may be drawn to the reviews on Plant pigments by Kuhn, Alkaloids by Robinson, Growth substances in plants by Thimann, Vitamins by Harris and Chemical embryology by Needham. While the Editors of the *Review* have provided us such a substantial quantity of useful information which will stimulate and inspire further inquiry, it may be considered ungrateful if we remark that some of the reviews read more like an assemblage of chemical abstracts. In future, with enlistment of the co-operation of the reviewers it should be possible to achieve the difficult task of maintaining a uniformly high standard and quality for all the branches of the subject reviewed.

The fact that the enterprise after the introductory three-year period, has been established as a non-profit corporation, is a fine testimony to the excellence, usefulness and popularity of the *Review*. It is a volume which will be found indispensable to every research worker.

M. S.

Cane Sugar Factory Control. By K. C. Banerji, F.S.T.A. (Indian Press, Ltd., Allahabad.) 1935. Pp. 436. Price, Foreign £1; Indian Rs. 13–8–0.

This book is divided into two parts. The first part contains fifteen chapters on the technical methods of chemical control and their principles, special reference being made to the recommendations of the "Uniformity Committee". The second part is a collection of 42 tables useful in the routine as well as special factory control work.

The official definitions of the "Uniformity Committee" are given in the first chapter with the author's explanatory notes wherever necessary. A separate chapter on sampling and weighing has been written. The methods of drying for moisture determination are treated in detail. The chapter on polariscope contains a concise explanation of the principles of polarisation, and a description of the different instruments and accessories.

Lane and Eynon's method for reducing sugars has been recommended for all determinations except for high grades for which Low's method should be employed. The description of both the volumetric and gravimetric methods for reducing sugars is full but the argument for including, in the same chapter, methods of ash determination is not convincing.

For mill control purposes, Noel Deerr's formula for the weight of mixed juice any other unknown quantity in the fundamental equation, has been favoured. The author has given a detailed description of Deerr's algebraic theory and concludes the chapter with a numerical example and the standard milling formulæ.

The chapter on boiling house control is well written. It contains the s.j.m. and the Winter-Carp-Geelig's formulæ and the different expressions for the "recovery" and "yield". Calculation is amply illustrated by numerical examples.

In spite of the numerous errors in the text, which are of a minor character and are incidental to a first publication, the subject-matter of the book is very well arranged and the finish given to it is quite up-to-date. The illustrations are apt and the compilation of tables quite comprehensive. With the latest informations like the International Committee recommendations, pH control, method of colloid estimation, etc., the book satisfies a real need of every sugar factory laboratory.

G. G. RAO.

The Bombay Grasses. By E. Blatter, S.J., Ph.D., F.L.S. and C. McCann, F.L.S. (*Scientific Monograph* No. 5, of the Imperial Council of Agricultural Research.)

The late Father Blatter was one of the most untiring of workers and one of the most prolific writers in the field of systematic botany in Western India for many years. Mr. McCann had during a long period collaborated with Father Blatter and this work, which appears above their joint names, represents an enormous amount of very careful labour in the field, the herbarium and the library. The bibliography is a complete list of references to grasses. The authors have wisely followed Stapf in the definition and sequence of the various divisions of the grasses and in this respect and others the book is up-to-date. The ecological side has not been forgotten and economic and medicinal uses are also mentioned, where known. A very valuable part of the book is composed of the excellent drawings done by Mr. R. K. Bhide, up till recently the Economic Botanist in the Nizam Dominions and previously a member of the Bombay Agricultural Department. A dissection under the dissecting microscope and a reference to these plates will often enable a quick diagnosis to be made—a diagnosis which might otherwise take a long time, particularly if some of the older descriptions have to be used for the identification of grasses.

As many of the grasses mentioned in this work are distributed widely over India, it is certain that the book will be in great demand by those who are interested in grass throughout the whole of the Indian Empire. While the book is primarily botanical and systematic, it will be found useful to those into whose spheres grasses come from the practical point of view, the workers in the Agricultural Department, the Forest Department, the Revenue Department, the scientific sections of Indian Universities and Colleges and the growing number of lovers of nature who are prepared to undergo the small discipline necessary to be able to follow a botanical description. A regrettable defect in this work is the binding, which is likely to give way at an early date and throughout the book the printer's ink appears to have been occasionally smudged.

W. B.

Birth Control To-Day. By Dr. Marie Carmichael Stopes. (John Bale Sons & Daniel Son, Ltd., 83–91, Great Tichfield Street, London, W. 1) 1934. Second Edition. Pages 237.

Since the publication in 1919 of *Wise Parenthood* Dr. Stopes has been contributing voluminously to the literature on contraception. In all her writings she has, to quote her own words, created a background of argument and sentiment behind the scientific exposition. The present book, which is addressed to those converts to Dr. Stopes's doctrines, who want a practical solution to their problems, is entirely devoid of sentiment and presents merely the essential facts about birth control in all its aspects.

At the outset the author cautions against those who, wilfully disregarding the fundamental teachings of contraception, resort to unnatural methods, and as a consequence wreck their own lives and are a menace to society as a whole. The book begins with laying before the reader the case for birth control and the relevant physiological facts. A unique feature of the book is that side by side with the orthodox methods some very efficient and cheap makeshifts have been indicated. It is very gratifying to note that in this particular, if in no other, the author's claim for the usefulness of the book to the less favoured section of our society is thoroughly justified.

The rapid spread of birth control knowledge in modern times has brought in its trail certain baneful results. In the hands of the ignorant, the methods of birth control are at once dangerous and undesirable. The author is keenly alive to this, and has, in a special chapter, dealt in an admirable manner, with the so-called "dangerous" methods. This section above all others must form the subject for serious study. That it is impossible to divorce sentiment entirely from such a human consideration as contraception is evident from the subject-matter of the ninth chapter; here the author has answered certain questions arising in the minds of persons troubled by qualms of conscience. These we hope will be useful in setting at rest all doubts of honest thinking folk. The value of the book is considerably enhanced by the inclusion, at the end, of some useful information about the working of Birth Control clinics and directions for the obtaining of first-hand knowledge. A short note appears about the legislation governing the practice of Birth Control by individuals and at clinics.

Admittedly it is the right of every individual to be equipped with the knowledge to control his most vital function and the publication of this book by a recognised authority is very opportune at a time when

the Public Health Commissioner in India has put up a plea for the control of population in this country.

C. N. R. R.

The Snakes of India. By Lieut.-Colonel K. G. Gharpurey, I.M.S. (The Popular Book Depot, Lamington Road, Grant Road, Bombay.) 1935. Pp. x + 165. 76 Figures. Price Rs. 3.

Gharpurey's *Snakes of India* is a popular book giving general information and useful knowledge about the various common snakes found in our country and is written in a simple, lucid style, calculated to make the subject both attractive and comprehensible to the layman. Beginning with a short Introduction, preceded by a page of "Errata" and quotation from Arnold's *Indian Idylls*, it comprises as many as 36 chapters dealing with almost every aspect of Indian Ophiology. The last chapter is by R. K. Golikere and makes a "World Survey of Dangerous Snakes". There are 76 figures, most of which are photographs. It is really unfortunate that in many cases the author has had to depend on photographs made from distorted, preserved specimens and has not been able to secure characteristic pictures of *live* specimens. A preserved specimen loses the pose, attitude and bodily configuration characteristic of a living one, and a picture made from it cannot give a faithful idea to the reader.

Here and there, though rather rarely, one comes across in Gharpurey's book facts which appear to be imprecisely expressed; but a book of such wide scope cannot be absolutely without faults and we can conscientiously recommend it to those who are interested in the subject.

As examples, we might mention that the author says, "in the majority of snakes, the female lays eggs *in the sun*" (p. 5; italics ours), a statement which we cannot endorse. On p. 6 he says that "the safest way to hold a snake is by its tail at arm's length. Then it may wriggle but cannot bite or twist round the arm." One might mention that snakes are supple creatures and even though they are gripped by the tail and kept at arm's length from the body, they can raise up their front half of the body by making a sort of loop and bite at one's hand. What the snake-charmers do is not only gripping a snake as described by the writer, but also continually giving it a gentle shake to prevent its reaching up.

On p. 49, Gharpurey says, "Snake-charmers ....are adroit in catching snakes. They are quick, and as soon as they see a snake, they grab it just behind the head, so that it cannot bite." The reviewer has accompanied snake-charmers once annually for the last nine years on snake-hunting in the jungles, but he has yet to see a snake-charmer who can grab a poisonous snake just behind the head, as soon as he sees it. If he did it, in all likelihood he would not live long to exhibit that snake to admiring spectators. Usually, the snake-charmer—and not all snake-charmers—can catch cobras fresh from the jungle—drags out a cobra from its hiding-place by the tail, keeps it at a yard's distance from his body, places a stick on its neck and by moving the stick carefully round, "pins" the head firmly to the ground. Then and only then it is that he ventures to grip its head in his hand. With a krait the process is doubly more difficult and it is only the most adroit snake-charmer who would try his hand at it.

On p. 4, the author says that "the bifid tongue probably conveys the sense of smell to the two nostrils". While this may be the usual idea, we should like to point out that one authority at least (Ditmars, 1922) believes that "*snakes hear with their tongues*" and that "the delicate, nerve-supplied tips of this wonderfully specialised organ are highly sensitive to vibrations from even slight sounds."

B. C. M.

Manual of Human Physiology. By Sir Leonard Hill, M.B., LL.D., F.R.S., Hon.A.R.I.A. (Edward Arnold & Co., London.) 1935. Fourth Edition, 484 pages with 186 diagrams. Price 6*s*. 6*d*.

The fourth edition of this excellent and popular manual of Human Physiology follows closely the pattern of the preceding one but is modified in accordance with recent discoveries. An important feature of the book is the inclusion of a much-needed chapter on Reproduction; it also contains suggestions for experiments with very simple and inexpensive apparatus. It is as complete and clear an account of Human Physiology as could be written for the use of "students training to qualify as teachers; for nurses undergoing hospital training and for the higher classes of schools and polytechnics". The treatment of the subject on the whole is such that it will be of great help to any

one interested in the teaching of elementary Physiology. There is an adequate index.

A. S. R.

Further Experiments upon the Water-Gas Process. By J. G. King, B.H. Williams, and R. V. Thomas. (Department of Scientific and Industrial Research. Fuel Research. Technical Paper No. 43, 1935.)

This publication is a sequel to the earlier studies in which methods were described to study the carbon and thermal balances in producer-gas process.

The investigations described in this paper are arranged in four parts. The first part is devoted to a study of the causes of clinker formation in the generator and the devices employed to minimise the accumulation of clinker, especially such as would adhere firmly to the walls of the generator and cause serious inconvenience. Observations of the distribution of temperature at various regions of the fuel-bed, as well as of the velocity of flow of gas at the sides and central regions of the generator provided data which suggested (*a*) that while charging the generator, a device should be employed to keep the larger lumps of coke in the centre and let the coke breeze pack the sides, and (*b*) that the grate should be so arranged that air flows into the fuel-bed at the centre of the grate. These two devices helped to keep the zones of high temperature in the fuel-bed in the centre, and to keep the walls relatively cool and also to prevent the coke-ash from overheating and lead to formation of large and hard masses of clinker. Such a generator was operated successfully for a considerable period with four different specimens of coke whose ash fusion temperatures (in a reducing atmosphere) ranged from 1200 to 1500° C.

The second part presents the results of investigations on the effect of the rate of blowing on the efficiency of the process. With the aid of general considerations from the thermal point of view of the reactions between air and carbon, and also of the conditions prevailing in the gas-generator, an equation has been developed to connect the efficiency of the process with the rate of blowing. Experimental studies with different rates of blowing were carried out with a view to ascertain the variation in composition of the blow-gas and also of the thermal losses incurred. The results obtained were in conformity with the theoretical considerations, *viz.*, the rate of blowing should be as high as practicable in order to reduce to a minimum the percentage of carbon monoxide and also to reduce thermal losses. It is at the same time necessary to regulate the period of blowing so as not to exceed the optimum temperature in the fuel-bed.

The effect of the size of coke on the efficiency of the process was studied systematically with reference to *effective surface*, *reactivity*, *time of contact*, composition of the gases obtained and thermal output. It was found that variations of the size of coke in the range 0·1″ to 3·0″ had no marked effect on the efficiency of the process.

The next point studied was the efficiency of the process when using different types of coke, *viz.*, vertical retort, horizontal retort and low-temperature coke. No significant variations were found, the process efficiencies being 72·4, 75·1 and 72·9 per cent. respectively.

The various sources of error which would tend to vitiate the results are examined in detail and presented in an appendix. These errors are small and are due to (*a*) hydrogen from sources other than the water-gas reaction, (*b*) nitrogen in the coke, (*c*) sulphur in the coke, (*d*) moisture in the air, and (*e*) dilution effects.

K. R. K.

Forthcoming Events.

4 Jan. 1936—The Second Indian Road Congress at Bangalore.

2—8 Jan. 1936—Indian Science Congress—23rd Annual Meeting, at the Daly College, and King Edward Hall, Indore.

2—4 Jan. 1936—All India Obstetric and Gynæcological Congress, 1936 (will be held at Madras).

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